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Jewels on the go: exotic buprestids around the world (Coleoptera, Buprestidae)

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Abstract

Buprestidae (Coleoptera: Buprestoidea) is one of the three wood-borer beetle groups of major phytosanitary interest worldwide, together with Cerambycidae and Scolytinae (Curculionidae). As in other beetle families, some buprestid species have been unintentionally or intentionally introduced around the world, in some cases causing significant environmental and economic damage in the invaded territories. Despite the phytosanitary relevance of the Buprestidae, information regarding the identity of exotic buprestids, their biogeographic areas of origin, introduction pathways, and larval host plants, have remained scattered in the literature. Our objective was to summarize much of the existing knowledge on these topics in the present paper. Our analysis resulted in a list of 115 exotic buprestids worldwide, representing introductions both within and between biogeographic realms and corresponding to less than 1% of the known buprestid species worldwide. Invasiveness does not seem to be linked to their larval host plant preferences, as introduced species utilize 158 plant genera in 70 plant families and are equally represented in all feeding guilds (monophagous, oligophagous, and polyphagous). As trade of plants or plant parts can serve as a pathway for future introductions, the information reported in this review can help in pest risk assessment.

Keywords

Biodiversity, exotic species, invasive alien species, jewel beetles

Introduction

Buprestidae Leach, 1815 (Coleoptera: Buprestoidea), commonly known as jewel beetles, include more than 15,000 described species distributed in all continents except Antarctica (Bellamy 2008). The family includes six subfamilies, namely Agrilinae, Buprestinae, Chrysochroinae, Galbellinae, Julodinae, and Polycestinae, (Bellamy 2003).

All Buprestidae are phytophagous and generally oligophagous (i.e., associated with a single plant family) as both adults and larvae (Curletti 1994). Buprestid larvae develop in both living and dead plant tissues; most species are internal feeders, boring or mining in roots, stems, branches, and leaves of both woody plants and herbaceous plants (Bellamy and Volkovitsh 2005), while only Julodinae possess soil-dwelling larvae that feed externally on roots (Kolibáč 2000).

Many buprestids, especially the wood-boring species, select dead, dying, or stressed plants for oviposition (Chamorro et al. 2015); however, some species are capable of infesting or even prefer healthy living hosts (Carlson and Knight 1969). This last group can have an important economic impact on human activities because it includes pests in orchards and tree plantations (Bonsignore et al. 2008; Hashim et al. 2018; Dawadi et al. 2019). Furthermore, buprestids can have substantial negative impacts on the natural ecosystems during outbreaks (Coleman et al. 2012; Muilenburg and Herms 2012; Sallé et al. 2014; Vuts et al. 2016; Haack and Petrice 2019).

The cryptic nature of most buprestid larvae, being hidden in woody tissues and, for some species, their slow larval development due to feeding in nutrient-poor xylem (Haack and Slansky 1987), has allowed multiple species to be transported in wood products and introduced to areas far from their place of origin. Much of this dispersal has been human-mediated and related to trade (Wu et al. 2017). One of the earliest accounts deals with the introduction of *Chalcophora detrita detrita* (Klug, 1829) from the Middle East to Southern Italy by the Etruscans or the Maritime Republics (from 1000 to 2000 years ago; Biagioni et al. 2015). However, since the end of the nineteenth century the introduction rate of exotic buprestids worldwide has substantially increased in similar fashion to many other invasive forest insects (Aukema et al. 2010; Chamorro et al. 2015; Hoebeke et al. 2017; Bozorov et al. 2018; Jendek et al. 2018; Roques et al. 2020; Volkovitsh et al. 2020).

Buprestidae have taken advantage of globalization with the opening of new trade routes and the increase in the number and speed of movement of goods and people (Pyšek and Richardson 2010). In some cases, species such as *Agrilus planipennis* Fairmaire, 1888 (hosts: *Chionanthus* and *Fraxinus* [main host]), *A. mali* Matsumura, 1924 (hosts: *Cydonia*, *Emmenopterys*, *Malus* [main], *Prunus*, *Pyrus*, *Sorbus*), and *Aphanisticus cochinchinae seminulum* Obenberger, 1929 (hosts: *Saccharum*, *Tripsacum*) have become invasive, causing significant damage in urban and natural forests and agriculture, and often requiring significant investments for monitoring and control (Hespenheide 2007; Bauer et al. 2008; Jones et al. 2013; Volkovitsh et al. 2020). Consequently, Buprestidae is one of the Coleoptera families of major silvicultural interest worldwide (Maynard et al. 2004; Inghilesi et al. 2013; Haack et al. 2014; MacQuarrie et al. 2020).

Given this condition, great efforts have been made in the last few decades to identify the main entry pathways, and to develop and implement early detection programs, effective monitoring strategies, and new tools for species identification (Meurisse et al. 2019; Poland and Rassati 2019). To date, however, little has been summarized about the main patterns of buprestid introductions worldwide, their taxonomic affinities, and their biogeographic origins.

The purpose of this article is to provide a comprehensive review of natural and human-assisted translocation of buprestid species among and within various biogeographic realms, describe the contribution of each realm and buprestid subfamily to this exchange of species, and provide the first comprehensive list of all introduced Buprestidae worldwide from the mid-1800s to present. Furthermore, a list of host plant associations at the genus and family level is provided, with an indication of the host range of each buprestid species. Our general aim is to provide information that can be used in pest risk assessment and invasion ecology.

Methods

In order to compile and then review the literature on exotic Buprestidae, we performed reiterated research in Google Scholar through the use of keywords such as "Buprestidae," "introduced," "exotic," and "alien" and then integrated with the Boolean operators AND, OR, NOT and the use of " " for specific word combinations. We also obtained a considerable amount of literature that was not available in Google Scholar thanks to the support of many colleagues and buprestid specialists. Screening of the literature collected was done following the PRISMA approach and only the papers retained are cited in the Suppl. material 1 and were used for the analysis (Moher et al. 2009). The resulting reference library included papers in Chinese, English, French, German, and Italian.

In the analysis, we considered only those publications where buprestids were identified to species or subspecies level, and for those records published between 1850 and December 2020. In the taxonomic discussion, we did not consider the rank of subgenus. In particular, the non-native status of a given species was evaluated for its consistency throughout the reviewed literature; in case there was only a single reference publication and in the absence of any further information, the non-native status of a species was considered as valid. For each species included in the present research, we considered the most recent and comprehensive publication highlighting and explaining the non-native status as a key reference. For those buprestid species for which the literature was limited, we referred to the original faunistic record published. A full list of the Buprestidae species, associated with the reference literature, is provided in Suppl. material 1.

Where the origin of a given taxon could not be assigned to a single biogeographic region, every possible area of origin was considered. The world's biogeographic areas considered in this paper generally follow the interpretation and categorization provided by Löbl and Löbl (2016).

At times it was difficult to know if an insect was firmly established in a new area or was simply intercepted at a port of entry, because papers varied in terminology and detail. In our dataset, when considering the species status, we have generally adopted the following categorization: A) Neonative: species native to a continent but introduced into regions other than the native ones either through natural spread indirectly favored by human activities (climate change, habitat change) or through accidental human-mediated introductions; B) Established: non-native species that sustain self-replacing populations over several life cycles (inclusive of single specimens collected in the wild away from potential entry points); C) Invasive: a non-native species established in natural or semi-natural ecosystems or habitat, which has impact and threatens native biological diversity; D) Intercepted: insects detected during inspection procedures or similar situations where no reproducing population is known to occur; E) Intentionally introduced: species that have been actively introduced in areas other than their native range with a specific purpose, such as biological control of invasive plants; F) Unclear: all species for which the status is unclear (e.g., apparently extinct adventive populations, species described in areas where that specific genus does not occur, species record vague without any specific detail, mislabeling and misidentification).

Data collected were organized in an Excel spreadsheet including the following information, organized by columns: subfamily, tribe, genus, species (full name plus author), biogeographic region of origin, biogeographic region of detection, status, and host plants. Detection region and host plant were associated with a specific column called references, which included all relevant information used to recover the data. Each species could have multiple entries (rows) in cases of multiple introduction events in different biogeographic areas, or in situations where the origin of the species was not reducible to a single biogeographic region. In the case of single introductions of widely distributed species in which it was clear the biogeographic region of origin of the insects, we considered only the record for that specific region. The taxonomy of plant genera and families used in the paper is based on the information available on the "Plants of The World Online" database (https://powo.science.kew.org/). Analyses and graphics were realized using the R software (version 4.1.2).

Host plant preference was defined in the categories: monophagous (for buprestids feeding only on plant species of the same genus), oligophagous (buprestids feeding on different plant genera within the same host family), polyphagous (buprestids feeding on plant species from different host families).

Results

Faunistic part

Our literature review identified 162 events of buprestid introductions among and within biogeographic regions that involved 115 distinct taxa (Suppl. material 1). The taxa included 44 species in the subfamily Agrilinae (tribes Agrilini, Aphanisticini, Coraebini, and Tracheini) (Table 1), 51 species of Buprestinae (tribes Anthaxiini,

Buprestini, Chrysobothrini, Curidini, Melanophilini, and Nascionini) (Table 2), 16 species of Chrysochroinae (Chalchophorini, Chrysochroini, Dicercini, Sphenopterini, Paraleptodemini, and Poecilonotini) (Table 3), and 6 species of Polycestinae (tribes Acmaeoderini, Polycestini, Prospherini and Ptosimini) (Table 4). No species of the subfamilies Galbellinae and Julodinae were recorded as introduced. The revision of all published records revealed that the buprestid species involved in introductions either within or between biogeographical realms constitute only 0.76% of all known buprestid species worldwide.

The analysis showed that the introduction of exotic Buprestidae included all biogeographic realms (with the obvious exclusion of the Antarctic realm), including introductions both among and within the realms (Fig. 1). In addition, our analysis revealed that the Nearctic and Palearctic bioregions contributed the greatest number of introduced species (90 in total) and also the most distinct introduction events (72.4% combined). The realm that was the source for the highest number of buprestids introduced elsewhere was the Palearctic, with 52 out of approximately 2,500 native species (2.1%), followed by the Nearctic (38 out of ~800; 4.8%), the Indomalayan (13 out of ~2,800; 0.5%), the Neotropical (13 out of ~3,700; 0.4%), the Australasian (10 out of ~1,600; 0.6%), the Afrotropical (7 out of ~3,800; 0.2%), and the Oceanian (2 out of ~70; 2.9%). The analyses between the number of buprestid species per biogeographic realm and the number of species introduced elsewhere from each realm did not show any significant statistical relation ($t = -0.10389$, $df = 5$, p-value = 0.9213).

Palearctic and Nearctic were the two regions with the highest number of introduced species (Fig. 1) but, despite somewhat similar environments, climate, and flora, there were substantial differences in the patterns of inter- and intra-biogeographic realm introductions (Table 5). In the case of intra-realm introductions, Palearctic and Nearctic showed a similar number of species (23 vs 20) despite the fact that the genera contributing to more than 50% of total introductions were, at least in part, different: *Agrilus* (9 species) and *Buprestis* (4 species) in the Palearctic, and *Chrysobothris* (9) and *Agrilus* (6) in the Nearctic.

By contrast, when considering introductions between the two realms, it was possible to observe a strong imbalance with 9 exotic species recorded in the Palearctic compared with 25 in the Nearctic. Furthermore, Agrilinae represented the majority of the exotic buprestids in the Nearctic, while Buprestinae were dominant in the Palearctic.

With respect to all buprestid species considered introduced worldwide, we found 41 cases where the species were considered established, 43 cases as interceptions at entry points, 32 cases where the status was unclear, and 22 cases of neonative species. We also classified 13 introductions where the species became invasive, and 6 cases where species were intentionally introduced.

For the 41 cases of establishment, Buprestinae was the most represented subfamily, with 23 records subdivided among the genera *Anthaxia* (1 species), *Buprestis* (8 species), *Belionota* (1 species), *Chrysobothris* (6 species), and *Trachypteris* (1 species). Agrilinae accounted for 14 establishments, represented by 10 species of *Agrilus*, 1 *Diphucrania*, and 2 *Trachys*. The subfamilies Chrysochroinae and Polycestinae were involved in only a limited number of establishments, i.e., 1 *Steraspis*, 1 *Prospheres* and 2 *Acmaeodera*.

Table 1. Subfamily Agrilinae: species list, biogeographic realms concerned, status, and larval host plants. * species confused with *Agrilus coxalis* Waterhouse, 1889 in the literature.

Species	Biogeographic realm		Status	Plant host genera
	origin	introduction		
Agrilus angustulus (Illiger, 1803)	Palearctic	Palearctic	Unclear	*Corylus*, *Ostrya* (Betulaceae); *Fagus*, *Castanea*, *Quercus* (Fagaceae)
Agrilus anxius Gory, 1841	Nearctic	Nearctic	Neonative	*Betula* (Betulaceae)
Agrilus auriventris Saunders, 1873	Australasian, Indomalayan	Oceanian	Invasive	*Citrus* (Rutaceae)
Agrilus auroguttatus Schaeffer, 1905*	Nearctic	Nearctic	Invasive	*Quercus* (Fagaceae)
Agrilus bilineatus (Weber, 1801)	Nearctic	Palearctic	Established	*Castanea*, *Quercus* (Fagaceae)
Agrilus biguttatus (Fabricius, 1776)	Palearctic	Australasian	Intercepted	*Fagus*, *Castanea*, *Quercus* (Fagaceae); *Tilia* (Malvaceae); *Populus* (Salicaceae); *Ulmus* (Ulmaceae)
Agrilus cavatus Chevrolat, 1838	Nearctic	Neotropical	Unclear	*Rhus* (Anacardiaceae); *Acaciella* (Fabaceae)
Agrilus convexicollis Redtenbacher, 1849	Palearctic	Palearctic	Neonative	*Euonymus* (Celastraceae); *Philadelphus* (Hydrangeaceae); *Fraxinus*, *Ligustrum*, *Olea*, *Syringa* (Oleaceae)
Agrilus cuprescens (Ménétriés, 1832)	Palearctic	Nearctic	Established	*Rosa*, *Rubus* (Rosaceae)
Agrilus cyanenoniger Saunders, 1873	Palearctic	Palearctic	Neonative	*Croton* (Euphorbiaceae); *Quercus* (Fagaceae)
Agrilus cyanescens (Ratzeburg, 1837)	Palearctic	Palearctic, Nearctic	Unclear, Established	*Lonicera*, *Symphoricarpos* (Caprifoliaceae); *Rhamnus* (Rhamnaceae)
Agrilus derasofasciatus Lacordaire, 1835	Palearctic	Nearctic	Non-native	*Vitis* (Vitaceae)
Agrilus difficilis Gory, 1841	Nearctic	Nearctic	Established	*Gleditsia* (Fabaceae); *Zanthoxylum* (Rutaceae)
Agrilus extraneus Fisher, 1933	Oceanian	Oceanian	Established	*Argemone* (Papaveraceae)
Agrilus fleischeri Obenberger, 1925	Palearctic	Nearctic	Intercepted	*Populus*, *Salix* (Salicaceae)
Agrilus furcillatus Chevrolat, 1835	Nearctic, Neotropical	Nearctic	Intercepted	*Pinus* (Pinaceae); *Zea* (Poaceae); Coffea (Rubiaceae); *Salix* (Salicaceae)
Agrilus graminis Kiesenwetter, 1857	Palearctic	Palearctic	Neonative	*Alnus*, *Corylus*, *Ostrya* (Betulaceae); *Euonymus* (Celesteraceae); *Castanea*, *Quercus* (Fagaceae); *Acer* (Sapindaceae); *Viburnum* (Viburnaceae)
Agrilus hyperici (Creutzer, 1799)	Palearctic	Australasian, Nearctic	Intentionally introduced	*Hypericum* (Hypericaceae)
Agrilus kaluganus Obenberger, 1940	Palearctic	Palearctic	Neonative	*Corylus* (Betulaceae)
Agrilus livens Kerremans, 1892	Indomalayan	Palearctic	Unclear	*Citrus* (Rutaceae)
Agrilus mali Matsumura, 1924	Palearctic	Palearctic	Neonative	*Cydonia*, *Malus*, *Prunus*, *Pyrus*, *Sorbus* (Rosaceae); *Emmenopterys* (Rubiaceae)
Agrilus nicolanus Obenberger, 1924	Palearctic	Palearctic	Neonative	*Quercus* (Fagaceae); *Ulmus* (Ulmaceae)
Agrilus occipitalis (Eschscholtz, 1822)	Australasian, Indomalayan, Palearctic	Oceanian	Invasive	*Citrus* (Rutaceae)
Agrilus pilosovittatus Saunders, 1873	Palearctic	Nearctic	Established	*Wisteria* (Fabaceae)
Agrilus planipennis Fairmaire, 1888	Palearctic	Nearctic, Palearctic	Invasive, Neonative	*Chionanthus*, *Fraxinus* (Oleaceae)
Agrilus prionurus Chevrolat, 1838	Nearctic	Nearctic	Neonative	*Chionanthus* (Oleaceae); *Sapindus* (Sapindaceae)
Agrilus pulchellus Bland, 1865	Nearctic	Nearctic	Intercepted	*Chrysothamnus* sp., *Erigeron* (Asteraceae); *Amsinkia* (Boraginaceae); *Celtis* (Cannabaceae); *Quercus* (Fagaceae); *Sphaeralcea* (Malvaceae); *Allionia*, *Boerhavia* (Nyctaginaceae)
Agrilus ribesi Schaefer, 1946	Palearctic	Nearctic	Invasive	*Ribes* (Grossulariaceae)
Agrilus sinuatus (Olivier, 1790)	Palearctic	Nearctic	Established	*Crataegus*, *Malus*, *Prunus*, *Pyrus*, *Sorbus* (Rosaceae)
Agrilus smaragdifrons Ganglbauer, 1890	Palearctic	Nearctic	Established	*Ailanthus* (Simaroubaceae)
Agrilus sulcicollis Lacordaire, 1835	Palearctic	Nearctic	Established	*Fagus*, *Castanea*, *Quercus* (Fagaceae)
Agrilus subrobustus Saunders, 1873	Indomalayan, Palearctic	Nearctic	Established	*Albizia* (Fabaceae)
Aphanisticus antennatus Saunders, 1873	Palearctic	Indomalayan, Neotropical	Unclear	Not available

Species	Biogeographic realm		Status	Plant host genera
	origin	introduction		
Aphanisticus cochinchinae seminulum Obenberger, 1929	Indomalayan	Nearctic, Neotropical, Oceanian	Invasive	*Saccharum*, *Tripsacum* (Poaceae)
Coraebus andrewesi Obenberger, 1922	Indomalayan, Palearctic	Neotropical	Unclear	Not available
Coraebus rubi (Linnaeus, 1767)	Palearctic	Palearctic	Neonative	*Rosa*, *Rubus* (Rosaceae)
Coraebus undatus (Fabricius, 1787)	Palearctic	Palearctic	Intercepted	*Diospyros* (Ebenaceae); *Castanea*, *Fagus*, *Quercus* (Fagaceae)
Diphucrania viridipurpurea Carter, 1924	Australasian	Palearctic	Established	Not available
Hylaeogena jureceki Obenberger, 1941	Neotropical	Afrotropical, Australasian	Intentionally introduced	*Dolichandra* (Bignoniaceae)
Leiopleura carbonata (LeConte, 1860)	Neotropical	Neotropical	Unclear	Not available
Leiopleura otero (Fisher, 1935)	Neotropical	Neotropical	Unclear	Not available
Lius poseidon Napp, 1972	Neotropical	Oceanian	Intentionally introduced	*Miconia*, *Chaetogastra* (Melastomataceae)
Trachys minutus (Linnaeus, 1758)	Palearctic	Nearctic	Established	*Corylus* (Betulaceae); *Sorbus* (Rosaceae); *Salix* (Salicaceae), *Ulmus* (Ulmaceae)
Trachys troglodytiformis Obenberger, 1918	Palearctic	Nearctic	Established	*Althea*, *Hibiscus*, *Malva* (Malvaceae)

Table 2. Subfamily Buprestinae: species list, biogeographic realms concerned, status, and larval host plants.

Species	Biogeographic realm		Status	Plant host genera
	origin	introduction		
Anthaxia godeti Gory & Laporte, 1839	Palearctic	Palearctic	Neonative	*Picea*, *Pinus* (Pinaceae)
Anthaxia laticeps Abeille de Perrin, 1900	Palearctic	Palearctic	Neonative	*Pinus* (Pinaceae)
Anthaxia proteus Saunders, 1873	Palearctic	Palearctic	Unclear	*Pinus* (Pinaceae)
Anthaxia salicis (Fabricius, 1776)	Palearctic	Nearctic	Established	*Castanea*, *Quercus* (Fagaceae); *Salix* (Salicaceae); *Acer* (Sapindaceae)
Cobosina willineri (Cobos, 1972)	Neotropical	Neotropical	Neonative	Not available
Buprestis apricans Herbst, 1801	Nearctic	Neotropical	Established	*Pinus* (Pinaceae)
Buprestis aurulenta Linnaeus, 1767	Nearctic	Australasian, Neotropical, Palearctic, Oceanian	Intercepted, Established, Unclear, Established	*Thuja*, *Juniperus* (Cupressaceae); *Abies*, *Picea*, *Pinus*, *Pseudotsuga* (Pinaceae)
Buprestis dalmatina Mannerheim, 1837	Palearctic	Nearctic, Palearctic	Intercepted Neonative	*Pinus* (Pinaceae)
Buprestis decora Fabricius, 1775	Nearctic	Neotropical, Palearctic	Established	*Pinus* (Pinaceae)
Buprestis haemorrhoidalis Herbst, 1780	Palearctic	Afrotropical, Australasian, Nearctic, Neotropical, Palearctic	Unclear, Intercepted, Established, Unclear, Unclear	*Callitris* (Cupressaceae); *Abies*, *Picea*, *Pinus* (Pinaceae)
Bruprestis humeralis Klug, 1829	Palearctic	Palearctic	Neonative	*Pinus* (Pinaceae)
Buprestis lineata Fabricius, 1781	Nearctic	Australasian, Nearctic, Neotropical, Palearctic	Intercepted, Neonative, Established, Unclear	*Pinus* (Pinaceae)
Buprestis maculativentris Say, 1825	Nearctic	Australasian	Intercepted	*Abies*, *Picea*, *Pinus* (Pinaceae)
Buprestis maculipennis Gory, 1841	Nearctic	Neotropical	Established	*Taxodium* (Cupressaceae); *Pinus*, *Tsuga* (Pinaceae)
Buprestis novemmaculata Linnaeus, 1767	Palearctic	Afrotropical, Indomalayan, Nearctic, Neotropical, Palearctic	Unclear, Unclear, Intercepted, Established, Established	*Larix*, *Picea*, *Pinus* (Pinaceae)
Buprestis salisburyensis Herbst, 1801	Nearctic	Nearctic	Established	*Pinus* (Pinaceae)

Species	Biogeographic realm		Status	Plant host genera
	origin	introduction		
Trachykele blondeli Marseul, 1865	Nearctic	Australasian, Palearctic	Intercepted, Non-native	*Calocedrus*, *Chamaecyparis*, *Cupressus*, *Juniperus*, *Thuja* (Cupressaceae)
Belionota prasina (Thunberg, 1789)	Australasian, Indomalayan	Afrotropical, Australasian, Nearctic, Neotropical Palearctic	Established, Intercepted, Established, Established, Intercepted	*Anacardium*, *Mangifera* (Anacardiaceae); *Delonix*, *Pithecellobium* (Fabaceae); *Casuarina* (Casuarinaceae); *Hopea* (Dipterocarpaceae); *Ceiba* (Malvaceae)
Merimna atrata (Gory & Laporte, 1837)	Australasian	Oceanian	Intercepted	*Eucalyptus* (Myrtaceae)
Chrysobothris adelpha Gemminger & Harold, 1869	Nearctic	Oceanian	Intercepted	*Prospis* (Fabaceae); *Carya* (Juglandaceae); *Amelanchier* (Rosaceae)
Chrysobothris acutipennis Chevrolat, 1835	Nearctic, Neotropical	Neotropical	Established	*Ebenopsis*, *Leucaena* (Fabaceae)
Chrysobothris affinis (Fabricius, 1794)	Palearctic	Australasian	Intercepted	*Pistacia* (Anacardiaceae); *Alnus*, *Betula*, *Carpinus*, *Corylus*, *Ostrya* (Betulaceae); *Cornus* (Cornaceae); *Arbutus* (Ericaceae); *Cercis*, *Gleditsia*, *Robinia* (Fabaceae); *Castanea*, *Fagus*, *Quercus* (Fagaceae); *Punica* (Lythraceae); *Juglans* (Juglandaceae); *Tilia* (Malvaceae); *Ficus*, *Morus* (Moraceae); *Eucalyptus* (Myrtaceae); *Fraxinus* (Oleaceae); *Cedrus* (Pinaceae); *Platanus* (Platanaceae); *Crataegus*, *Malus*, *Prunus*, *Pyrus*, Rosa, *Sorbus* (Rosaceae); *Populus*, *Salix* (Salicaceae); *Acer* (Sapindaceae); *Ulmus* (Ulmaceae)
Chrysobothris analis LeConte, 1860	Nearctic	Nearctic	Established	*Rhus* (Anacardiaceae); *Celtis* (Cannabaceae); *Diospyros* (Ebenaceae); *Cercis*, *Ebenopsis*, *Haematoxylum*, *Leucaena*, *Mimosa*, *Parkinsonia*, *Prosopis* (Fabaceae); *Carya*, *Juglans* (Juglandaceae); *Coccoloba* (Polygonaceae); *Prunus* (Rosaceae); *Citrus* (Rutaceae); *Sapindus* (Sapindaceae); *Ulmus* (Ulmaceae)
Chrysobothris cavifrons Deyrolle, 1864	Australasian	Palearctic	Intercepted	Not available
Chrysobothris cerceripraeda Westcott & Thomas, 2015	Nearctic	Nearctic	Unclear	Not available
Chrysobothris chrysonota Deyrolle, 1864	Australasian	Palearctic	Intercepted	Not available
Chrysobothris costata Kerremans, 1895	Oceanian	Oceanian	Invasive	*Intsia* (Fabaceae); *Citrus* (Rutaceae)
Chrysobothris costifrons Waterhouse, 1887	Nearctic	Nearctic	Neonative	*Quercus* (Fagaceae)
Chrysobothris dorsata (Fabricius, 1787)	Afrotropical, Palearctic	Palearctic	Unclear	*Acacia*, *Ceratonia* (Fabaceae)
Chrysobothris ellyptica Deyrolle, 1864	Australasian	Palearctic	Intercepted	Not available
Chrysobothris femorata (Olivier, 1790)	Nearctic	Australasian, Oceanian, Palearctic	Intercepted	*Liquidambar* (Altingiaceae); *Carpinus* (Betulaceae); *Celtis* (Cannabaceae); *Diospyros* (Ebenaceae); *Cercis* (Fabaceae); *Castanea*, *Quercus* (Fagaceae); *Carya*, *Juglans* (Juglandaceae); *Tilia* (Malvaceae); *Fraxinus* (Oleaceae); *Platanus* (Platanaceae); *Amelanchier*, *Crategus*, *Cydonia*, *Malus*, *Prunus*, *Sorbus* (Rosaceae); *Populus*, *Salix* (Salicaceae); *Acer* (Sapindaceae); *Ulmus* (Ulmaceae)
Chrysobothris igniventris Reitter, 1895	Palearctic	Nearctic	Intercepted	*Larix*, *Pinus* (Pinaceae)
Chrysobothris indica Castelnau & Gory, 1837	Indomalayan	Oceanian	Established	*Terminalia* (Combrentaceae); *Shorea* (Dipterocarpaceae); *Acacia* (Fabaceae); *Myristica* (Myristicaceae); *Mimusops* (Sapotaceae)
Chrysobothris knulli Nelson, 1975	Nearctic	Nearctic	Established	*Acacia* (Fabaceae)

Species	Biogeographic realm		Status	Plant host genera
	origin	introduction		
Chrysobothris mali Horn, 1886	Nearctic	Nearctic	Intercepted	*Alnus*, *Betula*, *Corylus* (Betulaceae); *Arbutus*, *Arctostaphylos* (Ericaceae); *Pickeringia*, *Prosopis*, *Wisteria* (Fabaceae); *Fagus*, *Quercus* (Fagaceae); *Ribes* (Grossulariaceae); *Juglans* (Juglandaceae); *Persea* (Lauraceae); *Liriodendron* (Magnioliaceae); *Ficus* (Moraceae); *Eucalyptus* (Myrtaceae); *Platanus* (Platanaceae); *Ceanothus*, *Rhamnus* (Rhamnaceae); *Adenostoma*, *Cercocarpus*, *Cotoneaster*, *Crataegus*, *Cydonia*, *Malus*, *Oemleria*, *Photinia*, *Prunus*, *Pyracantha*, *Pyrus*, *Rhaphiolepis*, *Rosa*, *Rubus*, *Sorbus* (Rosaceae); *Populus*, *Salix* (Salicaceae); *Acers*, *Aesculus* (Sapindaceae); *Ulmus* (Ulmaceae)
Chrysobothris octocola LeConte, 1858	Nearctic	Oceanian	Established	*Acacia*, *Parkinsonia*, *Prosopis* (Fabaceae); *Prunus* (Rosaceae); *Salix* (Salicaceae)
Chrysobothris pupureoplagiata Scheaffer, 1904	Nearctic	Nearctic	Intercepted	*Canotia* sp. (Celasteraceae), *Psorothamnus* (Fabaceae)
Chrysobothris quadriimpressa Gory & Laporte, 1837	Nearctic	Nearctic	Neonative	*Liquidambar* (Altaginaceae); *Quercus* (Fagaceae); *Juglans* (Juglandaceae); *Sapindus* (Sapindaceae)
Chrysobothris rotundicollis Gory & Laporte, 1837	Nearctic	Neotropical	Unclear	*Ebenopsis* (Fabaceae); *Larix*, *Pinus* (Pinaceae)
Chrysobothris rugosiceps Melsheimer, 1845	Nearctic	Nearctic	Neonative	*Castanea*, *Quercus* (Fagaceae)
Chrysobothris sexpunctata, Fabricius 1801	Neotropical	Neotropical	Established	Not available
Chrysobothris superba Deyrolle, 1864	Australasian	Palearctic	Intercepted	Not available
Chrysobothris tranquebarica (Gmelin, 1790)	Neotropical	Nearctic	Unclear	*Casuarina* (Casuarinaceae); *Conocarpus* (Combrentaceae); *Cassia* (Fabaceae); *Pinus* (Pinaceae); *Rhizophora* (Rhizophoraceae)
Chrysobothris trinervia (Kirby, 1837)	Nearctic	Nearctic	Intercepted	*Larix*, *Picea*, *Pinus*, *Pseudotsuga* (Pinaceae)
Anilara hoscheki Obenberger, 1916	Australasian	Palearctic	Intercepted	Not available
Melanophila consupta LeConte, 1857	Nearctic	Oceanian	Non-native	*Calocedrus* (Cupressaceae); *Eucalyptus* (Myrtaceae); *Pinus Pseudotsuga* (Pinaceae)
Phaenops cyanea (Fabricius, 1775)	Palearctic	Nearctic	Intercepted	*Abies*, *Larix*, *Pinus* (Pinaceae)
Phaenops drummondi (Kirby, 1837)	Nearctic	Nearctic, Palearctic	Intercepted	*Abies*, *Cedrus*, *Larix*, *Picea*, *Pseudotsuga* (Pinaceae)
Trachypteris picta decostigma (Fabricius, 1787)	Palearctic	Neotropical	Established	*Populus*, *Salix* (Salicaceae)
Nascio vetusta (Boisduval, 1835)	Australasian	Australasian	Intercepted	*Eucalyptus*, *Metrosideros* (Myrtaceae); *Xanthorrhoea* (Asphodelaceae)

With respect to the 43 cases where the buprestids were apparently only intercepted, the Buprestinae had the highest number of interceptions worldwide (28), which included 24 species. The most commonly intercepted genus was *Chrysobothris* (14 species), followed by *Buprestis* (6 species). There were 6 cases of intercepted Agrilinae, involving 4 species of *Agrilus* and 1 *Coraebus*. For both Chrysochroinae and Polycestinae there were multiple single species interceptions. For 28 species among Agrilinae, Buprestinae, Chrysochroinae and Polycestinae it was not possible to assign their status to any of the existing categories; therefore, they were classified as "unclear." We recognize that many more species of Buprestidae have been intercepted at ports throughout the world, but in almost all cases these datasets are not available to the public and therefore could not be considered in our paper.

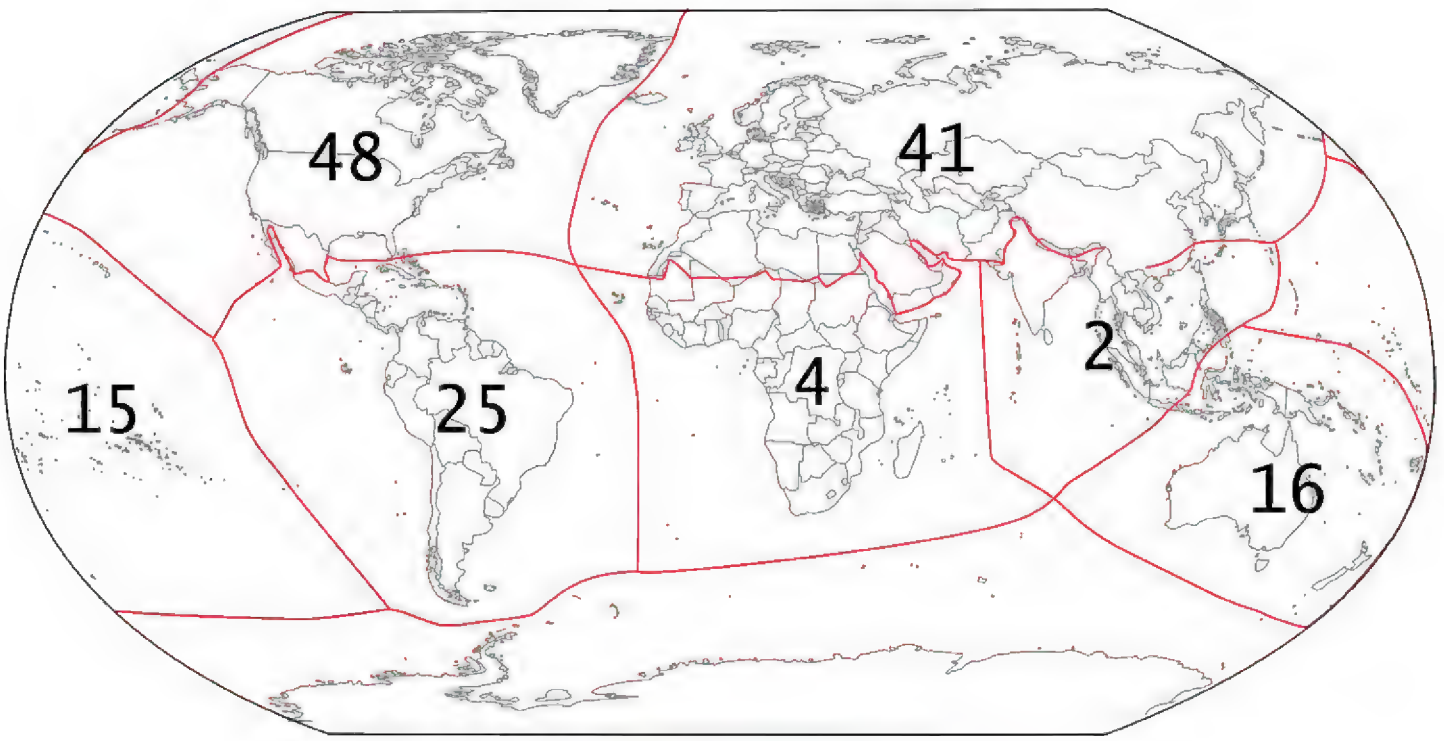
Table 3. Subfamily Chrysochroinae: species list, biogeographic realms concerned, status, and larval host plants.

Species	Biogeographic realm		Status	Plant host genera
	origin	introduction		
Chalcophora angulicollis (LeConte, 1857)	Nearctic	Nearctic, Palearctic	Unclear	*Abies*, *Pinus*, *Pseudotsuga* (Pinaceae)
Chalcophora japonica (Gory, 1840)	Palearctic	Nearctic	Intercepted	*Pinus* (Pinaceae)
Chalcophora virginiensis (Drury, 1770)	Nearctic	Neotropical, Palearctic	Unclear	*Taxodium* (Cupressaceae); *Pinus* (Pinaceae)
Cyphogastra foveicollis (Boisduval, 1835)	Australasian	Palearctic	Intercepted	Not available
Dicerca moesta (Fabricius, 1794)	Palearctic	Nearctic, Palearctic	Intercepted, Unclear	*Abies*, *Pinus*, *Picea* (Pinaceae)
Dicerca furcata (Thunberg, 1787)	Palearctic	Australasian	Intercepted	*Betula* (Betulaceae)
Dicerca tuberculata (Laporte & Gory, 1837)	Nearctic	Neotropical	Non-native	*Tsuga* (Pinaceae)
Euchroma gigantea (Linnaeus, 1758)	Neotropical	Neotropical	Unclear	*Ceiba*, *Pachira*, *Pseudobombax* (Malvaceae)
Lampetis bahamica Fisher, 1925	Neotropical	Neotropical	Intercepted	Not available
Lampetis corruscans (Carter, 1924)	Australasian	Australasian	Unclear	Not available
Lampetis fastuosa (Fabricius, 1775)	Australasian	Australasian	Unclear	*Areca* (Arecaceae); *Acacia* (Fabaceae); *Eucalyptus* (Myrtaceae); *Tectona* (Lamiaceae)
Lamprodila festiva (Linnaeus, 1767)	Palearctic	Palearctic	Neonative	*Callitris*, *Chamaecyparis*, *Cupressus*, *Juniperus*, *Platycladus*, *Tetraclinis*, *Thuja* (Cupressaceae); *Ziziphus* (Rhamnaceae); *Tamarix* (Tamaricaceae)
Lamprodila vivata (Lewis, 1893)	Palearctic	Nearctic	Intercepted	*Cryptomeria*, *Chamaecyparis*, *Juniperus* (Cupressaceae)
Sphenoptera jugoslavica Obenberger, 1926	Palearctic	Nearctic	Intentionally introduced	*Centaurea* (Asteraceae)
Steraspis squamosa (Klug, 1829)	Afrotropical, Palearctic	Palearctic	Established, Neonative	*Tamarix* (Tamaricaceae)

Table 4. Subfamily Polycestinae: species list, biogeographic realms concerned, status, and larval host plants.

Species	Biogeographic realm		Status	Plant host genera
	origin	introduction		
Acmaeodera bipunctata (Olivier, 1790)	Palearctic	Palearctic	Neonative	*Euphorbia* (Euphorbiaceae); *Juniperus*, *Thuja* (Cupressaceae); *Ficus* (Moraceae); *Abies*, *Cedrus*, *Larix*, *Pinus* (Pinaceae)
Acmaeodera flavomarginata (Gray, 1832)	Nearctic, Neotropical	Neotropical	Established	*Acacia*, *Prosopis* (Fabaceae); *Diospyros* (Ebenaceae)
Acmaeodera neoneglecta Fisher, 1949	Nearctic	Nearctic	Intercepted	*Acacia*, *Ebenopsis*, *Leucaena*, *Prosopis*, *Sophora* (Fabaceae); *Carya* (Juglandaceae); *Ulmus* (Ulmaceae)
Prospheres aurantiopictus (Laporte & Gory, 1837)	Australasian	Australasian	Established	*Araucaria* (Araucariaceae); *Pinus* (Pinaceae)
Ptosima undecimmaculata (Herbst, 1784)	Palearctic	Nearctic	Intercepted	*Mangifera* (Anacardiaceae); *Ceratonia* (Fabaceae), *Crataegus*, *Malus*, *Prunus*, *Pyrus* (Rosaceae); *Citrus* (Rutaceae); *Vitis* (Vitaceae)

Among all the taxa investigated, 22 species were considered as neonatives. There were 10 Agrilinae (9 *Agrilus* and 1 *Coraebus*); 9 Buprestinae (2 *Anthaxia*, 1 *Cobosina*, 3 *Buprestis*, and 3 *Chrysobothris*); 2 Chrysochroinae (1 *Steraspis* and 1 *Lamprodila*), and 1 Polycestinae (1 *Acmaeodera*). Neonative species were recorded almost exclusively in the Northern Hemisphere, with 15 species in the Palearctic and 6 in the



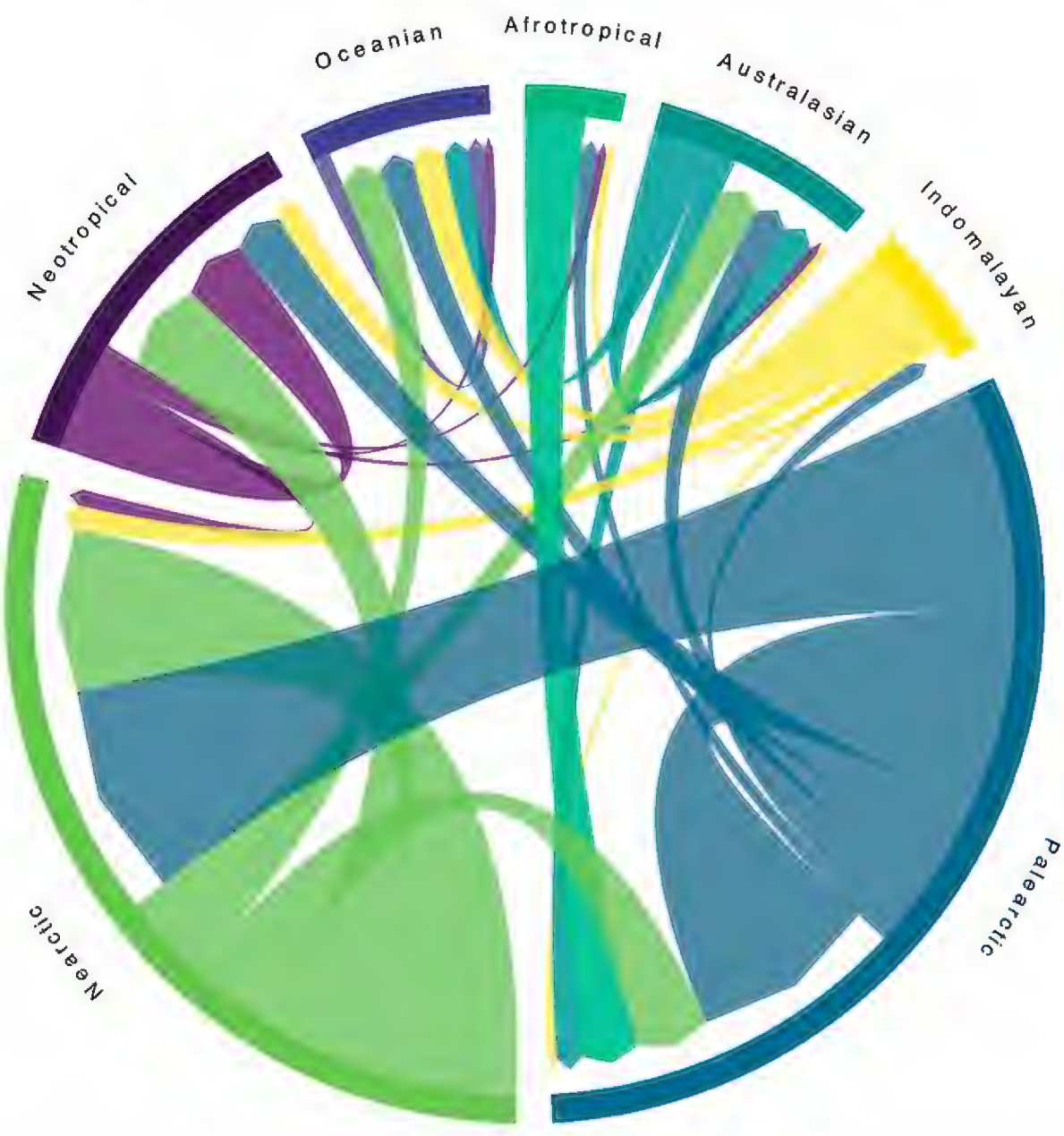


Figure 1. World map illustrating the number of introduced species of Buprestidae within and between biogeographic realms (above) and graphical representation of the exchanges (below), with the thickness of the arrows directly proportional to the number of introduction events. The length of the colored arc of each realm corresponds to the total number of introduced species, either in or out.

Table 5. Comparison between buprestid introductions within and between the Nearctic and Palearctic realms, with details on the number of species within each genus.

within Palearctic	within Nearctic	Palearctic to Nearctic	Nearctic to Palearctic
9 *Agrilus*	9 *Chrysobothris*	12 *Agrilus* (one species intentionally introduced)	3 *Buprestis*
4 *Buprestis*	6 *Agrilus*	3 *Buprestis*	2 *Chalcophora*
3 *Anthaxia*	2 *Buprestis*	2 *Trachys*	1 *Agrilus*
2 *Coraebus*	1 *Acmaeodera*	1 *Anthaxia*	1 *Chrysobothris*
1 *Acmaeodera*	1 *Chalcophora*	1 *Chalcophora*	1 *Phaenops*
1 *Chrysobothris*	1 *Phaenops*	1 *Chrysobothris*	1 *Trachykele*
1 *Dicerca*		1 *Dicerca*	
1 *Steraspis*		1 *Lamprodila*	
1 *Lamprodila*		1 *Phaenops*	
		1 *Ptosima*	
		1 *Sphenoptera* (intentionally introduced)	

Nearctic realm. *Agrilus* was the most represented genus in the Palearctic with 7 species, while *Chrysobothris* was the most represented genus in the Nearctic with 3 species. A single species of *Cobosina* was the only example of a neonative taxon in the Neotropic realm.

All 13 cases of invasive buprestids are species of Agrilinae and Buprestinae. These species became invasive once introduced to the Nearctic, Oceanian and Neotropical realms. There were 6 species of invasive Agrilinae (5 *Agrilus* and 1 *Aphanistichus*), and only two invasive Buprestinae in the genera *Belionota* and *Chrysobothris*.

Six cases of intentionally introduced taxa were found, representing 4 species in the genera *Agrilus* (Agrilini), *Sphenoptera* (Sphenopterini), *Hylaeogena* and *Lius* (Tracheini). These species were introduced into the Nearctic, Afrotropical, and Australasian realms.

Larval host plants

The analysis of larval host plants for all Buprestidae introduced worldwide identified 158 different plant genera within 70 families (3 Gymnosperms and 67 Angiosperms), with only a few introduced buprestids without host information (Tables 1–4). The exotic Buprestidae included sets of species with wide variation in the range of their larval hosts, varying from highly polyphagous on non-phylogenetically related plant families to monophagous on a single plant genus. Larval host specificity (i.e., monophagous, oligophagous and polyphagous) of introduced Buprestidae is equally distributed among the subfamilies (Kruskal-Wallis chi-squared = 1.2007, df = 2, *p*-value = 0.5486) (Table 6).

The larval host families most represented were Pinaceae (60 host records), Rosaceae (52), Fabaceae (49), Fagaceae (36), and Cupressaceae (24), which together accounted for 52% of all host records (Table 7). Considering introductions within and between biogeographic realms, it emerged that the most common genera of host plants varied greatly among world biogeographic realms, both in abundance and diversity (Table 8).

Table 6. Number of introduced species with different levels of larval host-use specialization by buprestid subfamilies.

	Monophagous	Oligophagous	Polyphagous	Unknown
Agrilinae	13	9	17	5
Buprestinae	11	11	20	8
Chrysochroinae	5	4	3	3
Polycestinae	0	0	6	0
Total	29	24	46	16

Table 7. Summary table of the main plant families and genera exploited as larval host plants by introduced Buprestidae by subfamily. Numbers between parenthesis refers to the number of records, not distinct species.

Plant Families	Plant Genera	Buprestid subfamilies	Buprestid genera
Pinaceae (60)	*Pinus* (27), *Abies* (8), *Picea* (8), *Larix* (7)	Buprestinae (45), Chrysochroinae (9), Polycestinae (4), Agrilinae (1)	*Buprestis* (21), *Chrysobothris* (10), *Phaenops* (8), *Chalcophora* (5)
Rosaceae (52)	*Prunus* (9), *Malus* (7), *Sorbus* (7), *Pyrus* (5)	Buprestinae (30), Agrilinae (15), Polycestinae (7)	*Chrysobothris* (30), *Agrilus* (10), *Ptosima* (4), *Acmaeoderella* (3)
Fabaceae (49)	*Acacia* (9), *Prosopis* (6), *Ebenopsis* (4), *Leucaena* (3)	Buprestinae (31), Polycestinae (14),	*Chrysobothris* (29), *Acmaeodera* (7), *Acmaeoderella* (6), *Agrilus* (3)
Fagaceae (35)	*Quercus* (18), *Castanea* (11), *Fagus* (6)	Agrilinae (20), Buprestinae (13), Polycestinae (2)	*Agrilus* (17), *Chrysobothris* (11), *Coraebus* (3)
Cupressaceae (23)	*Juniperus* (5), *Thuja* (4)	Chrysochroinae (11), Buprestinae (10), Polycestinae (2)	*Lamprodila* (10), *Trachykele* (5), *Buprestis* (2), *Acmaeodera* (2)
Betulaceae (18)	*Corylus* (6), *Betula* (4), Alnus (3)	Buprestinae (9), Agrilinae (8), Chrysochroinae (1)	*Chrysobothris* (9), *Agrilus* (7)
Salicaceae (16)	*Salix* (9), *Populus* (7)	Buprestinae (10), Agrilinae (5), Polycestinae (1)	*Chrysobothris* (7), *Agrilus* (4), *Trachypteris* (2)

Discussion

The low introduction rate, 0.76% compared for example to the 2.17% out of ~ 6000 taxa of Curculionidae Scolytinae (Lantschner et al. 2020), indicates a general low propensity for Buprestidae to be introduced by humans, either directly or indirectly. In support of this contention is the high number of single buprestid introductions (i.e., one species introduced only once and only in a single biogeographic realm), with respect to the total number of introduction events. In addition, the invasiveness does not seem to be linked to larval host plant preferences, as introduced species are included in all feeding guilds (monophagous, oligophagous, and polyphagous).

The genera *Agrilus* (Agrilinae: Agrilini), *Buprestis* (Buprestinae: Buprestini), and *Chrysobothris* (Buprestinae: Chrysobothrini) would seem to be more predisposed to introduction events than other genera, possibly owing to both their morphological and biological traits. *Agrilus* are generally small in size and univoltine (Solomon 1995; Chamorro et al. 2015). They infest mostly live plants and signs of their presence are difficult to detect prior to adult emergence and host dieback. Therefore, several *Agrilus* species have likely been moved over time through trade of live plants, such as ornamentals or nursery stock, as well as through domestic and international movements

Table 8. Summary table of the most common plant genera exploited as larval host plants by buprestid species introduced either within or between biogeographic realms.

Origin – Introduction realm	Most common larval host plant genera exploited by those species with a narrow host range
Afrotropical – Palearctic	Angiosperms: *Acacia*, *Ceratonia*, *Tamarix*
Australasian – Australasian	Angiosperms: *Eucalyptus*
Australasian – Oceanian	Angiosperms: *Citrus*
Australasian – Palearctic	Angiosperms: *Anacardium*, *Casuarina*, *Ceiba*, *Delonix*, *Hopea*, *Mangifera*, *Pithecellobium*
Indomalayan – Afrotropical	Angiosperms: *Anacardium*, *Casuarina*, *Ceiba*, *Delonix*, *Hopea*, *Mangifera*, *Pithecellobium*
Indomalayan – Australasian	Angiosperms: *Anacardium*, *Casuarina*, *Ceiba*, *Delonix*, *Hopea*, *Mangifera*, *Pithecellobium*
Indomalayan – Palearctic	Angiosperms: *Citrus*
Indomalayan – Nearctic	Angiosperms: *Albizia*, *Anacardium*, *Casuarina*, *Ceiba*, *Delonix*, *Hopea*, *Mangifera*, *Pithecellobium*, *Saccharum*, *Tripsacum*
Indomalayan – Neotropical	Angiosperms: *Anacardium*, *Casuarina*, *Ceiba*, *Delonix*, *Hopea*, *Mangifera*, *Pithecellobium*, *Saccharum*, *Tripsacum*
Indomalayan – Oceanian	Angiosperms: *Citrus*
Nearctic – Australasian	Gymnosperms: *Pinus*
Nearctic – Nearctic	Angiosperms: *Acacia*, *Juglans*, *Prosopis*, *Sapindus*, *Ulmus* Gymnosperms: *Pinus*, *Pseudotsuga*
Nearctic – Oceanian	Angiosperms: *Amelanchier*, *Carya*, *Prosopis*, *Prunus*, *Salix* Gymnosperms: *Pinus*, *Pseudotsuga*
Nearctic – Palearctic	Gymnosperms: *Abies*, *Pinus*, *Pseudotsuga*
Nearctic – Neotropical	Gymnosperms: *Pinus*
Neotropical – Afrotropical	Angiosperms: *Dolichandra*
Neotropical – Australasian	Angiosperms: *Dolichandra*
Neotropical – Nearctic	Gymnosperms: *Pinus*
Neotropical – Neotropical	Angiosperms: *Acacia*, *Ceiba*, *Diospyros*, *Ebenopsis*, *Leucaena*, *Pachira*, *Prosopis*, *Pseudobombax*
Neotropical – Oceanian	Angiosperms: *Miconia*, *Tibouchina*
Palearctic – Afrotropical	Gymnosperms: *Picea*, *Pinus*
Palearctic – Australasian	Angiosperms: *Castanea*, *Fagus*, *Populus*, *Quercus*, *Tilia Ulmus*
Palearctic – Indomalayan	Gymnosperms: *Larix*, *Picea*, *Pinus*
Palearctic – Nearctic	Angiosperms: *Salix* Gymnosperms: *Abies*, *Larix*, *Picea*, *Pinus*
Palearctic – Neotropical	Gymnosperms: *Picea*, *Pinus*
Palearctic – Oceanian	Angiosperms: *Citrus*
Palearctic – Palearctic	Angiosperms: *Castanea*, *Quercus* Gymnosperms: *Abies*, *Picea*, *Pinus*
Oceanian – Oceanian	Angiosperms: *Argemone*, *Citrus*, *Intsia*

of recently cut logs and manufactured wood products, especially when not debarked. The example of the emerald ash borer, *A. planipennis*, is remarkable in the number of pathways (e.g., logs, firewood, nursery stock) by which it has moved in North America (Herms and McCullough 2014; Haack et al. 2015).

By contrast to *Agrilus*, most *Buprestis* and *Chrysobothris* species have longer larval developmental periods; they can infest both living, stressed, and dead plants; and they typically tunnel in host xylem, including both sapwood and heartwood (Solomon 1995; Evans et al. 2004). As a consequence of this multi-year developmental period deep inside wood, infestations are generally difficult to detect until adult emergence. Although most species oviposit in bark cracks or under the bark, a few species can oviposit directly on exposed wood (xylem). Moreover, once larvae have entered the xylem, the presence of bark is no longer required. Therefore,

introductions of these species can result from movement of logs and milled wood products either with or without bark.

Given the relatively low number of exotic buprestids investigated and the heterogeneity of the sources consulted, it has not been possible to delineate an exact temporal trend for worldwide buprestid introductions, although it seems evident that most species were likely introduced before the 1970s, with very few ever intercepted during port surveys. This condition likely reflects the lack of strict phytosanitary regulations in the early 1900s (Eschen et al. 2015). In addition, international trade among European countries and their overseas colonies likely facilitated the movement of some species early on, as well as later during the two world wars. Examples come from *Buprestis aurulenta* Linnaeus, 1767 and *Buprestis novemmaculata* Linnaeus, 1767, two species introduced in all biogeographic realms edging the Atlantic Ocean, including Azores and Canary Islands, two important bridgeheads in the trade routes between Europe and the Americas (Steckley 1972; Crosby 1984; de Avilez Rocha 2019). Similarly, sugar cane cultivation is associated with the worldwide spread of *Aphanisticus cochinchinae seminulum* Obenberger, 1929 (Zack et al. 2009).

In more recent times, many examples of intracontinental spread of buprestids have been reported, especially for certain species of *Agrilus*, *Anthaxia*, and *Chrysobothris* (Westcott 2005; Fägerström et al. 2009; Izzillo 2013; Orlova-Bienkowskaja and Volkovitsh 2015; Westcott et al. 2018; Curletti and Ranghino 2020). Rapid intracontinental spread probably reflects greater connectivity among trading partners as well as increased speed of transport, especially in the European Union and North America. Range expansion of some neonative species has apparently resulted from human-caused climate and environmental changes, such as for *Agrilus graminis* Kiesenwetter, 1857; *Agrilus nicolanus* Obenberger, 1924; *Buprestis dalmatina* Mannerheim, 1837; *Lamprodila festiva* (Linnaeus, 1767). In the USA, the southward and westward spread of the native birch specialist *Agrilus anxius* Gory, 1841 has been attributed to the widespread planting of ornamental birch trees in many areas outside the native range of North American birch species (Muilenburg and Herms 2012).

It is interesting to note that most neonatives have caused little damage, although there are a few exceptions often associated with the inadvertent movement of infested live plants. For example, the introduction of *Agrilus planipennis* from Eastern Asia to the Moscow area resulted in severe mortality of ash (*Fraxinus*) trees in European Russia (Orlova-Bienkowskaja 2014); however, it is also plausible that *Agrilus planipennis* could have been introduced in Moscow on ash nursery stock imported from North America (Haack et al. 2015). Another example is *Lamprodila festiva* (Linnaeus, 1767), a southern European – circum-Mediterranean species, which has expanded its distribution northward and eastward, benefiting from extensive plantings of its host plants (Cupressaceae) as ornamental plants in private and public gardens (Nitzu et al. 2016; Rabl et al. 2017; Volkovitsh and Karpun 2017; Ruicănescu and Stoica 2019). Similarly, *Agrilus mali* Matsumura, 1924, an eastern Palearctic species, has taken advantage of expanding cultivation of Rosaceae fruit trees and patches of natural forest as a springboard to spread westward in the Palearctic (Volkovitsh et al. 2020; Zhang et al. 2021; Lu et al. 2022).

Only four buprestid species have been intentionally introduced as biological control agents against invasive weeds in North America, South Africa, and Australia. *Sphenoptera jugoslavica* Obenberger, 1926 has been intentionally introduced and successfully established in the western USA where it is used to control the invasive plant *Centaurea diffusa* Lam. (Asteraceae) (Lang et al. 1998); *Agrilus hyperici* (Creutzer, 1799) was introduced in the USA and Australia where it provides efficient control of invasive *Hypericum* species (Hypericaceae); while *Hylaeogena jureceki* Obenberger, 1941 was introduced and established with different rates of success in South Africa and Australia to control the invasive plant *Dolichandra unguis-cati* (L.) L.G.Lohmann (Bignoniaceae) (King et al. 2011; Snow and Dhileepan 2014). The Neotropical *Lius poseidon* Napp, 1972 was instead intentionally introduced to Hawai'i to control the invasive *Miconia crenata* (Vahl) Michelang (Melastomataceae); however, in Hawai'i the species naturally became a biocontrol agent of another invasive plant *Chaetogastra herbacea* (DC.) P.J.F.Guim. & Michelang. (Melastomataceae) (Culliney and Nagamine 2000; Conant and Hirayama 2001; Conant et al. 2013).

Conclusion

The family Buprestidae is highly diverse with a global distribution defined by multiple abiotic and biotic factors, including human-mediated introductions. Although some biological and ecological traits, such as apparent obligate outbreeding and obligate maturation feeding for all buprestids, can serve as barriers to successful establishment, the opening of new continental and intercontinental trade routes as well as the ever-increasing volume and types of goods and plants traded increases the risk of future introductions or passive diffusion of more buprestid species. With respect to climate change and the widespread practice of introducing exotic plants for ornamental, agricultural, and forestry purposes around the world, it will be important to identify possible new introduction pathways for exotic Buprestidae along with pest risk assessments. In this regard, more research is needed on buprestid taxonomy and ecology, together with training and funding of more buprestid specialists. The development of new technologies for rapid species identification, either morphological or molecular, would be very useful for the management of this important group of plant pests, which are becoming of increasing economic importance worldwide.

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References

Alfieri A (1976) The Coleoptera of Egypt. Mémoires de la Société Entomologique d'Egypte 5: 1–361.

Alonso-Zarazaga MA, Goldarazena A (2005) Presencia en el País Vasco de *Rhyephenes humeralis* (Coleoptera, Curcolionidae), plaga de *Pinus radiata* procedente de Chile. Boletin de la SEA 36: 143–152.

APHIS (1982) List of intercepted plant pests. Fiscal year 1982. USDA-APHIS-PPQ, APHIS 82–9: 1–195.

APHIS (1986) List of intercepted plant pests. Fiscal year 1985. USDA-APHIS-PPQ, APHIS 82–12: 1–229.

Arechavaleta M, Rodríguez S, Zurita N, García A (2010) Lista de Especies Silvestres de Canarias. Hongos, Plantas y Animales Terrestres. 2009. Gobierno de Canarias, 577 pp.

Arnaiz Ruiz L, Páramo PB, Zuzarte AJDS (2005) Dos nuevos bupréstidos para Portugal (Coleoptera: Buprestidae). Boletin de la SEA 1: 135–136.

Aukema JE, McCullough DG, Von Holle B, Liebhold AM, Britton K, Frankel SJ (2010) Historical accumulation of nonindigenous forest pests in the continental United States. Bioscience 60(11): 886–897. https://doi.org/10.1525/bio.2010.60.11.5

Basham JP, Waayers RJ, Westcott RL (2015) Discovery of *Chrysobothris costifrons costifrons* Waterhouse, 1887 (Coleoptera: Buprestidae) in southern California, USA. The Pan-Pacific Entomologist 91(2): 200–202. https://doi.org/10.3956/2015-91.2.200

Bauer LS, Liu H, Miller D, Gould J (2008) Developing a classical biological control program for *Agrilus planipennis* (Coleoptera: Buprestidae), an invasive ash pest in North America. Newsletter of the Michigan Entomological Society 53: 38–39.

Beeson CFC (1941) The Ecology and Control of the Forest Insects of India and the Neighboring Countries. Dehra Dun, 1007 pp.

Bella S, Sparacio I, Turrisi GF (2001) Prima segnalazione di *Chrysobothris dorsata* (Fabricius, 1787) in Italia (Coleoptera, Buprestidae). Il Naturalista Siciliano 25: 377–379.

Bellamy CL (2002) Zoological Catalogue of Australia: Buprestoidea. Coleoptera. CSIRO, Camberra, 598 pp.

Bellamy CL (2003) An illustrated summary of the higher classification of the superfamily Buprestoidea (Coleoptera). Folia Heyrovskiana Supp. 10: 1–197.

Bellamy CL (2008) A world catalogue and bibliography of the jewel beetles (Coleoptera: Buprestoidea) (Vol. 1–4). Pensoft Series Faunistica 76–79: 1–2684.

Bellamy CL, Volkovitsh MG (2005) Chapter 17. Buprestoidea Crowson, 1955. In: Beutel RG, Leschen RAB (Eds) Handbuch der Zoologie/Handbook of Zoology (Vol. IV), Arthropoda: Insecta, Part 38, Coleoptera, Beetles (Vol. 1): Morphology and Systematics. W. de Gruyter, Berlin/New York, 461–468. https://doi.org/10.1515/9783110904550.461

Bellamy CL, Williams GA, Hasenpusch J, Sundholm A (2013) A summary of the published data on host plants and morphology of immature stages of Australian jewel beetles (Coleoptera: Buprestidae), with additional new records. Insecta Mundi 0293: 1–172.

Biagioni A, Corsi F, Pezzo F, Tassi F (2015) Pinete costiere e necessità di conservazione forestale, faunistica e paesaggistica. Il Tombolo di Grosseto. In: Ciacio O (Ed.) Proceedings of the Second International Congress of Silviculture "Designing the future of the

forestry sector". Accademia Italiana di Scienze Forestali, Florence, 329–226. https://doi.org/10.4129/2cis-ab-pin

Bianchi FA (1981) Chrysobothris indica. Proceedings of the Hawaiian Entomological Society 33: e324.

Bílý S (2002) Summary of the bionomy of the buprestid beetles of Central Europe (Coleoptera: Buprestidae). Acta Entomologica Musei Nationalis Pragae (supplementum 10): 1–103.

Bílý S (2013) Revision of the *Anthaxia* (*Haplanthaxia*) *proteus* species group (Coleoptera: Buprestidae). European Journal of Entomology 90(2): 177–187.

Bolanakis I, Trichas A (2018) First record of *Steraspis squamosa* (Klug, 1829) in Europe (Greece, Crete) (Coleoptera, Buprestidae). Nachrichtenblatt der Bayerischen Entomologen 067: 108–111.

Bonsignore CP, Manti F, Vacante V (2008) Field and tree distribution of *Capnodis tenebrionis* (Linnaeus, 1767) (Col., Buprestidae) adults in an apricot orchard in Italy. Journal of Applied Entomology 132(3): 216–224. https://doi.org/10.1111/j.1439-0418.2007.01235.x

Borchert D, Newton L, Culliney T, Hartzog H, Ahern R, Garrett L (2010) Risk assessment of the movement of firewood within the United States [online]. United States Department of Agriculture, Animal and Plant Health Inspection Service, Raleigh, North Carolina, United States of America. https://www.aphis.usda.gov/import_export/plants/plant_imports/firewood/firewood_pathway_assessment.pdf [Accessed 20 September 2020]

Borges PAV, Costa A, Cunha R, Gabriel R, Gonçalves V, Martins AF, Melo I, Parente M, Raposeiro P, Rodrigues P, Serrão Santos R, Silva L, Vieira P, Vieira V (2010) A List of the Terrestrial and Marine Biota from the Azores. Princípia Editora, Cascais, 432 pp.

Bozorov TA, Luo Z, Li X, Zhang D (2018) *Agrilus mali* Matsumara (Coleoptera: Buprestidae), a new invasive pest of wild apple in western China: DNA barcoding and life cycle. Ecology and Evolution 9(3): 1160–1172. https://doi.org/10.1002/ece3.4804

Briese DT (1991) Current status of *Agrilus hyperici* (Coleoptera: Buprestidae) released in Australia in 1940 for the control of St John's wort: lessons for insect introductions. Biocontrol Science and Technology 1(3): 207–215. https://doi.org/10.1080/09583159109355200

Burke HE (1928) The Western Cedar Pole Borer or Powder Worm. Technical Bulletin No. 48, United States Department of Agriculture, Washington D.C., 16 pp.

Bytinski-Salz H (1966) An annotated list of insects and mites introduced into Israel. Israel Journal of Entomology 1: 15–48.

Callot H, Brua C (2010) Insectes invasifs et envahissants en Alsace. Bulletin de l'association philomatique d'Alsace et de Lorraine 2011: 21–44.

Campbell CL, McCaffrey JP (1991) Population trends, seasonal phenology, and impact of *Chrysolina quadrigemina*, *C. hyperici* (Coleoptera: Chrysomelidae), and *Agrilus hyperici* (Coleoptera: Buprestidae) associated with *Hypericum perforatum* in northern Idaho. Environmental Entomology 20(1): 303–315. https://doi.org/10.1093/ee/20.1.303

Carlson RW, Knight FB (1969) Biology, taxonomy, and evolution of four sympatric *Agrilus* beetles (Coleoptera: Buprestidae). Contributions of the American Entomological Institute 4: 1–105.

Carlton CE, MacRae TC, Tishechkin AK, Bayless VL, Johnson W (2018) Annotated checklist of the Buprestidae (Coleoptera) from Louisiana. Coleopterists Bulletin 72(2): 351–367. https://doi.org/10.1649/0010-065X-72.2.351

Chamorro ML, Jendek E, Haack RA, Petrice TR, Woodley NE, Konstantinov S, Volkovitsh MG, Yang X-K, Grebennikov VV, Lingafelter SW (2015) Illustrated Guide to the Emerald ash Borer *Agrilus planipennis* Fairmaire and Related Species (Coleoptera, Buprestidae). Pensoft Publishers, Sofia, 200 pp.

Ciesla P (1992) Introduction of bark beetles and wood borers into China in coniferous logs from North America. FAO (Food and Agriculture Organization of the United Nations). Plant Protection Bulletin 40: 154–158.

Clark WH, Westcott RL (2017) *Chrysobothris knulli* Nelson, 1975 (Coleoptera: Buprestidae) in Baja California Sur, Mexico. Coleopterists Bulletin 71(3): 434–436. https://doi.org/10.1649/0010-065X-71.3.434

Clermont J (1924) Sur la capture à Paris du *Buprestis* (*Chalcophora*) *angulicollis* Lee. Bulletin de la Société Entomologique de France 29(13): 139–140. https://doi.org/10.3406/bsef.1924.27347

Coleman TW, Seybold SJ (2009) Previously unrecorded damage to oak, *Quercus* spp., in southern California by the goldspotted oak borer, *Agrilus coxalis* Waterhouse (Coleoptera: Buprestidae). The Pan-Pacific Entomologist 84(4): 288–300. https://doi.org/10.3956/2008-18.1

Coleman TW, Seybold SJ (2011) Collection history and comparison of the interactions of the goldspotted oak borer, *Agrilus auroguttatus* Schaeffer (Coleoptera: Buprestidae), with host oaks in southern California and southeastern Arizona, USA. Coleopterists Bulletin 65(2): 93–108. https://doi.org/10.1649/072.065.0224

Coleman TW, Graves AD, Hoddle M, Heath Z, Chen Y, Flint ML, Seybold SJ (2012) Forest stand composition and impacts associated with *Agrilus auroguttatus* Schaeffer (Coleoptera: Buprestidae) and *Agrilus coxalis* Waterhouse in oak woodlands. Forest Ecology and Management 276: 104–117. https://doi.org/10.1016/j.foreco.2012.03.011

Coleman TW, Chen Y, Graves AD, Hishinuma SM, Grulke NE, Flint ML, Seybold SJ (2014) Developing monitoring techniques for the invasive goldspotted oak borer (Coleoptera: Buprestidae) in California. Environmental Entomology 43(3): 729–743. https://doi.org/10.1603/EN13162

Conant P, Hirayama C (2001) A new host record for *Lius poseidon* Napp (Coleoptera: Buprestidae). Proceedings of the Hawaiian Entomological Society 35: e147.

Conant P, Garcia JN, Johnson MT, Nagamine WT, Hirayama CK, Markin GP, Hill RL (2013) Releases of natural enemies in Hawaii since 1980 for classical biological control of weeds. In: Wu Y, Johnson T, Sing S, Raghu, S, Wheeler G, Pratt P, Warner K, Center T, Goolsby J, Reardon R (Eds) Proceedings of the XIII International Symposium on Biological Control of Weeds; September 11–16, 2011; Waikoloa, Hawaii, USA. US Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team 2012-07. Fort Collins, Colorado, 230–242.

Crosby AW (1984) An Ecohistory of the Canary Islands: A precursor of European colonialization in the New World and Australasia. Environmental Review 8(3): 215–235. https://doi.org/10.2307/3984323

Cui ZJ, Zhang YL, Zhang X, Luo ZH, Zhang P, Golec J, Poland TM, Zalucki MP, Lu ZZ (2019) Life history and mortality factors of *Agrilus mali* Matsumura (Coleoptera: Buprestidae) in wild apples in Northwestern China. Agricultural and Forest Entomology 21(3): 309–317. https://doi.org/10.1111/afe.12333

Culliney TW, Nagamine WT (2000) Introductions for biological control in Hawaii, 1987–1996. Proceedings of the Hawaiian Entomological Society 34: 101–113.

Curletti G (1994) I Buprestidi d'Italia: Catalogo tassonomico, sinonimico, biologico, geonemico. Natura Bresciana 19: 1–318.

Curletti G (2005) Insecta Coleoptera Buprestidae. In: Ruffo S, Stoch F (Eds) Checklist e distribuzione della fauna italiana. Memorie del Museo Civico di Storia Naturale di Verona, 2. serie, Sezione Scienze della Vita. Comune di Verona, Verona, 205–206.

Curletti G, Ranghino S (2020) Una nuova presenza per la fauna italiana: *Anthaxia* (*Haplanthaxia*) *laticeps laticeps* Abeille de Perrin, 1900 (Coleoptera, Buprestidae). Rivista piemontese di storia naturale 41: 139–140

Dawadi S, Oliver JB, O'Neal P, Addesso KM (2019) Management of flatheaded appletree borer (*Chrysobothris femorata* Olivier) in woody ornamental nursery production with a winter cover crop. Pest Management Science 75(7): 1971–1978. https://doi.org/10.1002/ps.5310

de Avilez Rocha G (2019) The Azorean connection trajectories of slaving, piracy, and trade in the early Atlantic. In: Altman I,Wheat D (Eds) The Spanish Caribbean and the Atlantic World in the Long Sixteenth Century. Univerity of Nebraska Press, 257–278. https://doi.org/10.2307/j.ctvfjcwtk.18

Denux O, Zagatti P (2010) Coleoptera families other than Cerambycidae, Curculionidae *sensu lato*, Chrysomelidae *sensu lato* and Coccinelidae. Chapter 8.5. Alien terrestrial arthropods of Europe. BioRisk 4: 315–406. https://doi.org/10.3897/biorisk.4.61

Dhileepan K, Taylor DB, Lockett C, Treviño M (2013) Cat's claw creeper leaf-mining jewel beetle *Hylaeogena jureceki* Obenberger (Coleoptera: Buprestidae), a host-specific biological control agent for *Dolichandra unguis-cati* (Bignoniaceae) in Australia. Australian Journal of Entomology 52(2): 175–181. https://doi.org/10.1111/aen.12014

DiGirolomo MF, Jendek E, Grebennikov VV, Nakladal O (2019) First North American record of an unnamed West Palaearctic *Agrilus* (Coleoptera: Buprestidae) infesting European beech (*Fagus sylvatica*) in New York City, USA. European Journal of Entomology 116: 244–252. https://doi.org/10.14411/eje.2019.028

Dodds KJ, Gilmore DW, Seybold SJ (2004) Ecological risk assessments for insect species emerged from western larch imported to northern Minnesota. College of Natural Resources and Minnesota Agricultural Experiment Station University of Minnesota (St. Paul, Minnesota). Staff Paper Series (174): 1–57.

EPPO (2019) *Chrysobothris femorata* (flat-headed apple tree borer): addition to the EPPO Alert List. https://gd.eppo.int/reporting/article-6633 [Accessed: 25 October 2020]

EPPO (2020) EPPO Datasheet: *Agrilus fleischeri* (AGRLFL). https://gd.eppo.int/taxon/AGRLFL/datasheet [Accessed: 12 September 2020]

Eschen R, Britton K, Brockerhoff E, Burgess T, Dalley V, Epanchin-Niell RS, Gupta K, Hardy G, Huang Y, Kenis M, Kimani E, Li HM, Olsen S, Ormrod R, Otieno W, Sadof C, Tadeu E, Theyse M (2015) International variation in phytosanitary legislation and regulations governing importation of plants for planting. Environmental Science & Policy 51: 228–237. https://doi.org/10.1016/j.envsci.2015.04.021

Estay SA (2016) Invasive insects in the Mediterranean forests of Chile. In: Paine TS, Lieutier F (Eds) Insects and Diseases of Mediterranean Forest Systems. Springer, Cham, 379–396. https://doi.org/10.1007/978-3-319-24744-1_13

Evans HF, Moraal LG, Pajares JA (2004) Biology, ecology and economic importance of Buprestidae and Cerambycidae. In: Lieutier F, Day KR, Battisti A, Grégoire J-C, Evans HF (Eds) Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis. Springer, Dordrecht, 447–474. https://doi.org/10.1007/978-1-4020-2241-8_20

Fägerström C, Bygebjerg R, Jonasson T (2009) Smalpraktbaggen *Agrilus cyanescens* (Coleoptera: Buprestidae) funnen i Sverige: en art under invandring? Entomologisk Tidskrift 130: 137–140.

Girard DH (1968) List of intercepted plant pests, 1967. USDA-APHIS-PPQ, APHIS 82-6-3: 1–89.

Girard DH (1969) List of intercepted plant pests, 1968. USDA-APHIS-PPQ, APHIS 82-6-4: 1–77.

Girard DH (1973) List of intercepted plant pests, 1971. USDA-APHIS-PPQ, APHIS 82-3: 1–81.

Girard DH (1974) List of intercepted plant pests, 1972. USDA-APHIS-PPQ, APHIS 82-4: 1–96.

Haack RA (2006) Exotic bark-and wood-boring Coleoptera in the United States: Recent establishments and interceptions. Canadian Journal of Forest Research 36(2): 269–288. https://doi.org/10.1139/x05-249

Haack RA, Petrice TR (2019) Historical population increases and related inciting factors of *Agrilus anxius*, *Agrilus bilineatus*, and *Agrilus granulatus liragus* (Coleoptera: Buprestidae) in the Lake states (Michigan, Minnesota, and Wisconsin). Great Lakes Entomologist 52: 13–21.

Haack RA, Slansky F (1987) Nutritional ecology of wood-feeding Coleoptera, Lepidoptera, and Hymenoptera. In: Slansky F, Rodriguez JG (Eds) Nutritional ecology of insects, mites, spiders and related invertebrates. Wiley, New York, 449–486.

Haack RA, Jendek E, Houping L, Marchant KR, Petrice TR, Poland TM, Ye H (2002) The emerald ash borer: A new exotic pest in North America. Newsletter of the Michigan Entomological Society 47: 1–5.

Haack RA, Petrice TR, Zablotny JE (2009) First report of the European oak borer, *Agrilus sulcicollis* (Coleoptera: Buprestidae), in the United States. Great Lakes Entomologist 42: 1–7.

Haack RA, Britton KO, Brockerhoff EG, Cavey JF, Garrett LJ, Kimberley M, Lowenstein F, Nuding A, Olson LJ, Tumer J, Vasilaky KN (2014) Effectiveness of the International Phytosanitary Standard ISPM No. 15 on reducing wood borer infestation rates in wood packaging material entering the United States. PLoS ONE 9(5): e96611. https://doi.org/10.1371/journal.pone.0096611

Haack RA, Baranchikov Y, Bauer LS, Poland TM (2015) Emerald ash borer biology and invasion history. In: Van Driesche R, Duan J, Abell K, Bauer L, Gould J (Eds) Biology and Control of Emerald Ash Borer. FHTET-2014-09, USDA Forest Service, Forest Health Technology Enterprise Team. Morgantown, 13 pp.

Haavik LJ, Coleman TW, Flint ML, Venette RC, Seybold SJ (2012) *Agrilus auroguttatus* exit hole distributions on *Quercus agrifolia* boles and a sampling method to estimate their density on individual trees. Canadian Entomologist 144(6): 733–744. https://doi.org/10.4039/tce.2012.68

Haavik LJ, Coleman TW, Flint ML, Venette RC, Seybold SJ (2014) Densities of *Agrilus auroguttatus* and other borers in California and Arizona oaks. Insects 5(1): 287–300. https://doi.org/10.3390/insects5010287

Hamilton J (1894) Catalogue of the Coleoptera Common to North America, Northern Asia and Europe, with Distribution and Bibliography. Transactions of the American Entomological Society 21: 345–416.

Haneda NF, Furqan M, Suheri M (2020) Stem borer insects on *Hopea odorata* in Bogor, West Java, Indonesia. Biodiversitas 21(11): 5308–5316. https://doi.org/10.13057/biodiv/d211135

Harris A (2011) *Dicerca furcata* (Coleoptera: Buprestidae) and *Popillia japonica* (Coleoptera: Scarabaeidae): further species of beetles found on imported used vehicles, but not established in New Zealand. Weta : News Bulletin of the Entomological Society of New Zealand Inc 41: 43–44.

Hashim SM, Abd El-Moaty RM, Tadros AW (2018) Monitoring the flatheaded borer *Ptosima undecimmaculata* Herbst (Coleoptera: Buprestidae) in orange orchards in Egypt. Egyptian Journal of Agricultural Research 96(3): 933–941. https://doi.org/10.21608/ejar.2018.138444

Hawkeswood TJ (2006) Review of the biology of *Prospheres aurantiopictus* (Laporte & Gory, 1837) (Coleoptera: Buprestidae). Calodema 5: 3–4.

Hawkeswood TJ (2007) Review of the biology of the genus *Merimna* Saunders, 1868 (Coleoptera: Buprestidae). Calodema 9: 12–13.

Hellrigl KG (1978) Ökologie und Brutpflanzen europäischer Prachtkäfer (Col., Buprestidae) Teil 1. Zeitschrift für Angewandte Entomologie 85(1–4): 167–191. https://doi.org/10.1111/j.1439-0418.1978.tb04028.x

Herms DA, McCullough DG (2014) Emerald ash borer invasion of North America: History, biology, ecology, impacts, and management. Annual Review of Entomology 59(1): 13–30. https://doi.org/10.1146/annurev-ento-011613-162051

Hespenheide HA (2003) A reconsideration of *Pachyschelus schwarzi* Kerremans and a review of American *Pachyschelus* north of México (Coleoptera: Buprestidae). Coleopterists Bulletin 57(4): 459–468. https://doi.org/10.1649/584

Hespenheide HA (2007) Expanded distribution of *Aphanisticus cochinchinae* Obenberger (Coleoptera, Buprestidae) in the New World. Coleopterists Bulletin 61(2): e164. https://doi.org/10.1649/0010-065X(2007)61[164:EDOACO]2.0.CO;2

Hespenheide HA (2018) *Euchroma gigantea* (Eucroma, giant metallic ceiba borer). In: Janzen DH (Ed.) Costa Rican Natural History. University of Chicago Press, Chicago, 719 pp.

Hespenheide HA, Chaboo CS (2015) Beetles (Coleoptera) of Peru: A survey of the families. Buprestidae. Journal of the Kansas Entomological Society 88(2): 211–214. https://doi.org/10.2317/kent-88-02-211-214.1

Hilburn DJ, Gordon RD (1989) Coleoptera of Bermuda. The Florida Entomologist 72(4): 673–692. https://doi.org/10.2307/3495046

Hızal E, Arslangündoğdu Z (2018) The first record of two-lined chestnut borer *Agrilus bilineatus* (Weber, 1801) (Coleoptera: Buprestidae) from Europe. Entomological News 127(4): 333–335. https://doi.org/10.3157/021.127.0404

Hoebeke ER, Wheeler Jr AG (2011) *Agrilus subrobustus* Saunders (Coleoptera: Buprestidae): new southeastern US records of an Asian immigrant on mimosa, *Albizia julibrissin* (Fabaceae). Proceedings of the Entomological Society of Washington 113(3): 315–324. https://doi.org/10.4289/0013-8797.113.3.315

Hoebeke ER, Jendek E, Zablotny JE, Rieder R, Yoo R, Grebennikov VV, Ren L (2017) First North American records of the east Asian metallic wood-boring beetle *Agrilus smaragdifrons* Ganglbauer (Coleoptera: Buprestidae: Agrilinae), a specialist on tree of heaven (*Ailanthus altissima*, Simaroubaceae). Proceedings of the Entomological Society of Washington 119(3): 408–422. https://doi.org/10.4289/0013-8797.119.3.408

Howarth FG, Preston DJ (2002) Baseline survey of arthropods (insects and relatives) of Kahului airport environs, Maui, Hawaii: Final report. Hawaiian Biological Survey Contribution

(2001-009). Noda & Associates and State of Hawaii, Department of Transportation, Airports Division, Honolulu, 93 pp.

Humble LM, Allen EA (2006) Forest biosecurity: Alien invasive species and vectored organisms. Canadian Journal of Plant Pathology 28(sup1): 256–269. https://doi.org/10.1080/07060660609507383

Inghilesi AF, Mazza G, Cervo R, Gherardi F, Sposimo P, Tricarico E, Zapparoli M (2013) Alien insects in Italy: Comparing patterns from the regional to European level. Journal of Insect Science 13(73): e73. https://doi.org/10.1673/031.013.7301

Ivie MA, Medrano-Cabral S, Martinéz ER (2014) *Chalcophora virginiensis* (Drury, 1770) (Coleoptera: Buprestidae), a Newly Established Invasive Species in the Dominican Republic. Coleopterists Bulletin 68(4): 712–713. https://doi.org/10.1649/0010-065X-68.4.712

Izzillo F (2013) Dati inediti sulla presenza di alcune interessanti specie di Buprestidi in Campania, Puglia e Basilicata. Quaderno di Studi e Notizie di Storia Naturale della Romagna 37: 221–228.

Jendek E (2013) Revision of the *Agrilus occipitalis* species-group (Coleoptera, Buprestidae, Agrilini). ZooKeys 256: 35–79. https://doi.org/10.3897/zookeys.256.4272

Jendek E (2016) Taxonomic, nomenclatural, distributional and biological study of the genus *Agrilus* (Coleoptera: Buprestidae). Journal of Insect Biodiversity 4(2): 1–57. https://doi.org/10.12976/jib/2016.4.2

Jendek E, Grebennikov VV (2009a) Revision of the *Agrilus cyanescens* species-group (Coleoptera: Buprestidae) with description of three new species from the east Palaearctic region. Zootaxa 2139(1): 43–60. https://doi.org/10.11646/zootaxa.2139.1.3

Jendek E, Grebennikov VV (2009b) *Agrilus sulcicollis* (Coleoptera: Buprestidae), a new alien species in North America. Canadian Entomologist 141(3): 236–245. https://doi.org/10.4039/n09-021

Jendek E, Grebennikov VV (2011) *Agrilus* (Coleoptera, Buprestidae) of East Asia. Jan Farkač, Prague, 362 pp.

Jendek E, Nakládal O (2019) Revision of citrus trees pests of *Agrilus angulatus* species-group (Coleoptera, Buprestidae) from South and Southeast Asia with description of one new species. Journal of Asia-Pacific Entomology 22(1): 316–332. https://doi.org/10.1016/j.aspen.2019.01.004

Jendek E, Poláková J (2014) Host Plants of World *Agrilus* (Coleoptera, Buprestidae). A Critical Review. Springer, Cham, 706 pp. https://doi.org/10.1007/978-3-319-08410-7

Jendek E, Grebennikov VV, Bocak L (2015) Undetected for a century: Palaearctic *Agrilus ribesi* Schaefer (Coleoptera: Buprestidae) on currant in North America, with adult morphology, larval biology and DNA barcode. Zootaxa 4034(1): 112–126. https://doi.org/10.11646/zootaxa.4034.1.5

Jendek E, Poláková J, Szopa R, Kodada J (2018) *Lamprodila* (*Palmar*) *festiva* (Coleoptera, Buprestidae) a new adventive jewel beetle pest of Cupressaceae in Slovakia. Entomofauna Carpathica 30: 13–24.

Jones MI, Coleman TW, Graves AD, Flint ML, Seybold SJ (2013) Sanitation options for managing oak wood infested with the invasive goldspotted oak borer (Coleoptera: Buprestidae) in southern California. Journal of Economic Entomology 106(1): 235–246. https://doi.org/10.1603/EC12177

Kelnarova I, Jendek E, Grebennikov VV, Bocak L (2019) First molecular phylogeny of *Agrilus* (Coleoptera: Buprestidae), the largest genus on Earth, with DNA barcode database for forestry pest diagnostics. Bulletin of Entomological Research 109(2): 200–211. https://doi.org/10.1017/S0007485318000330

King AM, Williams HE, Madire LG (2011) Biological control of cat's claw creeper, *Macfadyena unguis-cati* (L.) AH Gentry (Bignoniaceae), in South Africa. African Entomology 19(2): 366–377. https://doi.org/10.4001/003.019.0213

Kirichenko N, Augustin S, Kenis M (2019) Invasive leafminers on woody plants: A global review of pathways, impact, and management. Journal of Pest Science 92(1): 93–106. https://doi.org/10.1007/s10340-018-1009-6

Kishio O (1981) Ecology and damage of the jewel beetle in the Shikoku region. Forest Quarantine 30: 108–112.

Kolibáč J (2000) Classification and phylogeny of the Buprestoidea (Insecta: Coleoptera). Acta Musei Moraviae. Scientiae Biologicae 85: 113–184.

Kulkarni HD (2010) Indigenous insect pests-*Batocera* and *Apriona* beetle attack on eucalyptus. Karnataka Journal of Agricultural Sciences 23: 207–210.

Lang RF, Poper GL, Coombs EM (1998) Establishment and redistribution of *Sphenoptera jugoslavica* Obenberger (Coleoptera: Buprestidae) for biological control of diffuse knapweed (*Centaurea diffusa* Lamarck) in the midwestern and western United States. The Pan-Pacific Entomologist 74: 27–31.

Lantschner MV, Corley JC, Liebhold AM (2020) Drivers of global Scolytinae invasion patterns. Ecological Applications 30(5): e02103. https://doi.org/10.1002/eap.2103

Levey B (1978) A taxonomic revision of the genus *Prospheres* (Coleoptera: Buprestidae). Australian Journal of Zoology 26(4): 713–726. https://doi.org/10.1071/ZO9780713

Löbl I, Löbl D (2016) Catalogue of Palaearctic Coleoptera (Vol. 3). Revised and Updated Edition. Brill, Leiden, 984 pp. https://doi.org/10.1163/9789004309142_002

Lorubio D, Cancelliere G, Izzillo F (2018) First records of acclimatized populations of *Buprestis dalmatina* in Italy (Coleoptera: Buprestidae). Fragmenta Entomologica 50: 53–56. https://doi.org/10.4081/fe.2018.284

Lu Z, Liu X, Wang T, Zhang P, Wang Z, Zhang YJ, Kriticos DJ, Zalucki MP (2022) Malice at the Gates of Eden: Current and future distribution of *Agrilus mali* threatening wild and domestic apples. Bulletin of Entomological Research 112(6): 1–13. https://doi.org/10.1017/S000748532200013X

MacQuarrie CJ, Gray M, Lavallé R, Noseworthy MK, Savard M, Humbl LM (2020) Assessment of the systems approach for the phytosanitary treatment of wood infested with wood-boring insects. Journal of Economic Entomology 113(2): 679–694. https://doi.org/10.1093/jee/toz331

Maier CT (2005) First records of alien insects in Connecticut (Orthoptera: Tettigoniidae; Coleoptera: Buprestidae, Chrysomelidae; Diptera: Rhagionidae, Tephritidae; Hymenoptera: Megachilidae). Proceedings of the Entomological Society of Washington 107: 947–959.

Maier CA, Ivie MA (2013) Reevaluation of *Chalcophora angulicollis* (LeConte) and *Chalcophora virginiensis* (Drury) with a review and key to the North American species of *Chalcophora* Dejean (Coleoptera: Buprestidae). Coleopterists Bulletin 67(4): 457–469. https://doi.org/10.1649/0010-065X-67.4.457

Maynard GV, Hamilton JG, Grimshaw JF (2004) Quarantine-phytosanitary, sanitary and incursion management: An Australian entomological perspective. Australian Journal of Entomology 43(3): 318–328. https://doi.org/10.1111/j.1326-6756.2004.00441.x

Meurisse N, Rassati D, Hurley BP, Brockerhoff EG, Haack RA (2019) Common pathways by which non-native forest insects move internationally and domestically. Journal of Pest Science 92(1): 13–27. https://doi.org/10.1007/s10340-018-0990-0

Mifsud D, Bílý S (2002) Jewel beetles (Coleoptera, Buprestidae) from the Maltese Islands (Central Mediterranean). The Central Mediterranean Naturalist 3: 181–188.

Milligan RH (1966) Overseas wood-and bark-boring insects intercepted at New Zealand ports. Technical Paper – Forest Research Institute. New Zealand Forest Service 13: 1–61.

Mito T, Uesugi T (2004) Invasive alien species in Japan: The status quo and the new regulation for prevention of their adverse effects. Global Environmental Research 8: 171–193.

Moher D, Liberati A, Tetzlaff J, Altman DG (2009) Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. Journal of Clinical Epidemiology 62(10): 1006–1012. https://doi.org/10.1016/j.jclinepi.2009.06.005

Moore T (1986) Aporte al conocimiento de los bupréstidos de Chile (Coleoptera: Buprestidae). Tercera contribución. Revista Chilena de Entomologia 13: 37–46.

Moore T, Diéguez VM (2018) Notas sobre la presencia de *Buprestis* (*Cypriacis*) *aurulenta* Linnaeus en Chile y Perú (Coleoptera: Buprestidae). Revista Chilena de Entomologia 44: 71–73.

Moore T, Pineda C (2016) Primer registro para Chile de *Cobosina willineri* (Cobos) (Coleoptera: Buprestidae). Revista Chilena de Entomologia 41: 96–98.

Muilenburg VL, Herms D (2012) A review of bronze birch borer (Coleoptera: Buprestidae) life history, ecology, and management. Environmental Entomology 41(6): 1372–1385. https://doi.org/10.1603/EN12238

Mumford BC (1967) List of intercepted plant pests, 1966. USDA-APHIS-PPQ, APHIS 82-6-1: 1–85.

Mumford BC (1967) List of intercepted plant pests, 1966. United States Department of Agriculture, Agricultural Research Service, Plant Quarantine Division, Washington D.C., 86 pp.

Nelson GH (1981) A new tribe, genus, and species of North American Buprestidae with consideration of subfamilial and tribal categories. Coleopterists Bulletin 35: 431–450.

Nelson GH, Verity DS, Westcott RL (1981) Additional notes on the biology and distribution of Buprestidae (Coleoptera) of North America. Coleopterists Bulletin 35: 129–152.

Nelson GH, Walters Jr GC, Haines RD, Bellamy CL (2008) A catalog and bibliography of the Buprestoidea of America North of Mexico. The Coleopterists Society, Special Publication 4: 1–274.

Niehuis M (1990) Beitrag zur kenntnis der *Buprestis*-arten des Nahen Ostens (Coleoptera: Buprestidae). Zoology in the Middle East 4(1): 39–60. https://doi.org/10.1080/09397140.1990.10637588

Niehuis M (2001) Australian jewel beetle (Coleoptera: Buprestidae) introduced in Spain. Boletin de la SEA 28: e116.

Nishida GM (2002) Hawaiian terrestrial arthropod checklist. Bishop Museum Technical Report, 210. Hawaii Biological Survey, Bishop Museum, Honolulu, 313 pp.

Nitzu E, Dobrin I, Dumbravă M, Gutue M (2016) Range expansion of *Ovalisia festiva* (Linnaeus, 1767) (Coleoptera: Buprestidae) in Eastern Europe and its damaging potential for

Cupressaceae. Travaux du Muséum National d'Histoire Naturelle. Travaux du Museum National d'Histoire Naturelle "Grigore Antipa" / Muzeul National de Istoire Naturala "Grigore Antipa" 58(1–2): 51–57. https://doi.org/10.1515/travmu-2016-0006

Orlova-Bienkowskaja MJ (2014) Ashes in Europe are in danger: The invasive range of *Agrilus planipennis* in European Russia is expanding. Biological Invasions 16(7): 1345–1349. https://doi.org/10.1007/s10530-013-0579-8

Orlova-Bienkowskaja MJ, Belokobylskij SA (2014) Discovery of the first European parasitoid of the emerald ash borer *Agrilus planipennis* (Coleoptera: Buprestidae). European Journal of Entomology 111(4): 594–596. https://doi.org/10.14411/eje.2014.061

Orlova-Bienkowskaja MJ, Volkovitsh MG (2015) Range expansion of *Agrilus convexicollis* in European Russia expedited by the invasion of the emerald ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae). Biological Invasions 17(2): 537–544. https://doi.org/10.1007/s10530-014-0762-6

Orlova-Bienkowskaja MJ, Drogvalenko AN, Zabaluev IA, Sazhnev AS, Peregudova E, Mazurov SGV, Komarov EV, Bieńkowski AO (2019) Bad and good news for ash trees in Europe: alien pest *Agrilus planipennis* has spread to the Ukraine and the south of European Russia, but does not kill *Fraxinus excelsior* in the forests. BioRxiv: e689240. https://doi.org/10.1101/689240

Parker A, Skipp SK (2018) A specimen of *Coraebus rubi* (Linnaeus, 1767) (Buprestidae) found in North Lincolnshire. Coleopterist 27: 115–118.

Peck SB (2005) A checklist of the beetles of Cuba with data on distributions and bionomics. (Insecta, Coleoptera). Arthropods of Florida and neighboring land areas 18: 1–214.

Peck SB (2009) The beetles of Barbados, West Indies (Insecta: Coleoptera): diversity, distribution and faunal structure. Insecta Mundi 73: 1–51.

Peck SB, Thomas MC (1998) Arthropods of Florida and Neighboring Land Areas (Vol. 16), A Distributional Checklist of the Beetles (Coleoptera) of Florida. Entomology Contribution No. 862, Florida Department of Agriculture and Consumer Services, Gainesville, 180 pp.

Peck SB, Thomas MC, Turnbow Jr RH (2014) The diversity and distributions of the beetles (Insecta: Coleoptera) of the Guadeloupe Archipelago (Grande-Terre, Basse-Terre, La Désirade, Marie-Galante, Les Saintes, and Petite-Terre). Lesser Antilles. Insecta Mundi 352: 1–156.

Petrice TR, Haack RA (2014) Biology of the European oak borer in Michigan, United States of America, with comparisons to the native twolined chestnut borer. Canadian Entomologist 146(1): 36–51. https://doi.org/10.4039/tce.2013.58

Poland TM, Rassati D (2019) Improved biosecurity surveillance of non-native forest insects: A review of current methods. Journal of Pest Science 92(1): 37–49. https://doi.org/10.1007/s10340-018-1004-y

Pyšek P, Richardson DM (2010) Invasive species, environmental change and management, and health. Annual Review of Environment and Resources 35(1): 25–55. https://doi.org/10.1146/annurev-environ-033009-095548

Rabl D, Rabl C, Rabl S (2017) The Mediterranean distributed Cypress jewel beetle *Ovalisia festiva* (Linnaeus, 1767) has reached the east of Austria (Coleoptera: Buprestidae). Entomologische Zeitschrift 127: 109–111.

Ramasamy M (2019) A scientific note on occurrence and infestation of jewel beetle *Belionota prasina* (Coleoptera: Buprestidae) on cashew (*Anacardium occidentale*). National Academy Science Letters 42(2): 91–94. https://doi.org/10.1007/s40009-018-0706-2

Roques A, Shi J, Auger-Rozenberg M-A, Ren L, Augustin S, Luo Y (2020) Are invasive patterns of non-native insects related to woody plants differing between Europe and China? Frontiers in Forests and Global Change 2: e91. https://doi.org/10.3389/ffgc.2019.00091

Ruicănescu A, Stoica AI (2019) The distribution and behaviour studies on a new invasive Buprestid species, *Lamprodila festiva* (Coleoptera: Buprestidae) in Romania. Travaux du Muséum National d'Histoire Naturelle. Grigore Antipa 62: 43–56. https://doi.org/10.3897/travaux.62.e38488

Ruseva S, Todorov I, Pencheva A (2020) New data on *Ovalisia* (*Palmar*) *festiva* (Linnaeus) (Coleoptera: Buprestidae) and its natural enemies reported from Bulgaria. Ecologica Montenegrina 28: 53–60. https://doi.org/10.37828/10.37828/em.2020.28.9

Saiki R, Tamadera Y, Watanabe K, Fukutomi H (2018) New distributional records of *Aphanisticus antennatus* Saunders (Coleoptera, Buprestidae) from Iriomote-jima Island, the Ryukyus, Japan. Elytra, Tokyo, (n. ser.) 8: 173–174.

Sallé A, Nageleisen LM, Lieutier F (2014) Bark and wood boring insects involved in oak declines in Europe: Current knowledge and future prospects in a context of climate change. Forest Ecology and Management 328: 79–93. https://doi.org/10.1016/j.foreco.2014.05.027

Sato S, Matsumoto T, Okuda S (2007) Hinoki cypress damage caused by the jewel beetle. Forestry and Pharmaceuticals 182: 22–26.

Schnepp KE, Ashman KL, Moore MR (2020) Report of an established population of *Belionota prasina* (Thunberg) (Coleoptera: Buprestidae: Buprestinae) in Florida, USA. Coleopterists Bulletin 74(1): 124–126. https://doi.org/10.1649/0010-065X-74.1.124

Sharaf El-Din AAA, Agamy EA (2000) Bioecology of the buprestid borer, *Ptosima undecimmaculata* (Herbst, 1784) Herbst (Coleoptera: Buprestidae): a pest of grapevine. Journal of Agricultural Science. Mansoura University 25: 5469–5481. https://doi.org/10.21608/jppp.2000.259584

Shine C, Reaser J, Gutierrez A (2003) Invasive Alien Species in the Austral-Pacific Region. National Reports & Directory of Resources. Global Invasive Species Programme, Cape Town, 185 pp.

Snow EL, Dhileepan K (2014) The jewel beetle (*Hylaeogena jureceki*): a new biological control for cat's claw creeper (*Dolichandra unguis-cati*) in Queensland. In 19th Australasian Weeds Conference," Science, Community and Food Security: the Weed Challenge", Hobart, Tasmania, Australia, 1–4 September 2014. Tasmanian Weed Society, Hobart, 50–54.

Solomon JD (1995) Guide to Insect Borers in North American Broadleaf Trees and Shrubs. Forest Service Agriculture Handbook AH-706. United States Department of Agriculture, Washington DC, 747 pp.

Starr F, Starr K (2012) New arthropod records from Maui, Molokaʻi, and Lānaʻi1. In: Evenhuis NL, Eldredge LG (Eds) Records of the Hawaii Biological Survey for 2011. Bishop Museum Occasional Papers 112: 39–42. https://doi.org/10.26515/rzsi/v112/i4/2012/122017

Steckley GF (1972) Trade at the Canary Islands in the Seventeenth-century. PhD thesis. University of Chicago, Chicago.

Swezey HO (1942) Miscellaneous families of Guam Coleoptera. Insects of Guam–I. Bernice P. Bishop Museum Bulletin 172: 150–171.

Taniwaki T (2006) Distribution patterns of emergence holes of *Buprestis haemorrhoidalis japonensis* (Coleoptera: Buprestidae) on *Pinus densiflora*: Comparison with four pinewood borers. Journal of Field Science-Tokyo University of Agriculture and Technology (Japan) 5: 9–15.

Thailand Nature Project (2020) *Belionota prasina*. https://www.thailandnatureproject.com/belionota-prasina.html [Accessed: 15 September 2020]

Volkovitsh MG (2021) Synopsis of the host plants of the Palaearctic Jewel Beetles of the Tribe Acmaeoderini (Coleoptera, Buprestidae: Polycestinae). Entomological Review 101(4): 465–518. https://doi.org/10.1134/S0013873821040035

Volkovitsh MG, Karpun NN (2017) A new invasive species of buprestid beetles in the Russian fauna: *Lamprodila* (*Palmar*) *festiva* (L.) (Coleoptera, Buprestidae), a pest of Cupressaceae. Entomological Review 97(4): 425–437. https://doi.org/10.1134/S0013873817040042

Volkovitsh MG, Kovalev AV, Orlova-Bienkowskaja MJ (2020) Current distribution and diagnostic features of two potentially invasive Asian buprestid species: *Agrilus mali* Matsumura and *A. fleischeri* Obenberger (Coleoptera: Buprestidae). Insects 11(8): 493. https://doi.org/10.3390/insects11080493

Vuts J, Woodcock CM, Sumner ME, Caulfield JC, Reed K, Inward DJ, Leather SR, Pickett JAA, Birkett MA, Denman S (2016) Responses of the two-spotted oak buprestid, *Agrilus biguttatus* (Coleoptera: Buprestidae), to host tree volatiles. Pest Management Science 72(4): 845–851. https://doi.org/10.1002/ps.4208

Westcott RL (1990) Notes on taxonomy, ecology and distribution for some species of *Chrysobothris* Eschscholtz (Coleoptera: Buprestidae) occurring in the United States (including Hawaii) and Canada. Coleopterists Bulletin 44: 323–343.

Westcott RL (2005) A new species of *Chrysobothris* Eschscholtz from Oregon and Washington, with notes on other Buprestidae (Coleoptera) occurring in the United States and Canada. Zootaxa 1044(1): 1–15. https://doi.org/10.11646/zootaxa.1044.1.1

Westcott RL (2007) The exotic *Agrilus subrobustus* (Coleoptera: Buprestidae) is found in northern Georgia. Coleopterists Bulletin 61(1): 111–112. https://doi.org/10.1649/968.1

Westcott RL, Murray T (2012) An exotic leafminer, *Trachys minutus* (L.) (Coleoptera: Buprestidae), found in Massachusetts, USA. Coleopterists Bulletin 66(4): 360–361. https://doi.org/10.1649/072.066.0413

Westcott RL, Thomas MC (2015) A new species of *Chrysobothris* Eschscholtz (Coleoptera: Buprestidae) from nests of *Cerceris fumipennis* Say (Hymenoptera: Crabronidae) in northeastern Florida, USA, with new state records for species of *Chrysobothris* and a list of buprestid prey species taken by the wasp in Florida. Insecta Mundi 417: 1–10.

Westcott RL, Barr WF, Nelson GH, Verity DS (1979) Distributional and biological notes on North and Central American species of *Acmaeodera* (Coleoptera: Buprestidae). Coleopterists Bulletin 33: 169–181.

Westcott RL, Haines RD, Hishinuma SM, Nelson LJ, Seybold SJ (2015) *Chrysobothris analis* LeConte, 1860 (Coleoptera: Buprestidae) discovered in California with notes on *Chrysobothris wintu* Wellso & Manley, 2007. The Pan-Pacific Entomologist 91(4): 337–341. https://doi.org/10.3956/2015-91.4.337

Westcott RL, Williams W, Kohler G (2018) *Chrysobothris rugosiceps* Melsheimer (Coleoptera: Buprestidae) found in Washington state. Insecta Mundi (653): 1–3.

Westcott RL, Williams W, Grotta A (2019) The exotic *Agrilus cyanescens* (Ratzeburg) (Coleoptera: Buprestidae) is discovered in Oregon. Insecta Mundi 0724: 1–5.

Wheeler WH, Hunt JM, Reagan EP (1950) List of intercepted plant pests, 1948. Department of Agriculture, Bureau of Entomology and Plant Quarantine, San Diego, 59 pp.

Wu Z, Zhang N, Li K, Wu Y, Lin Y, Ji H (2016) Identification of *Coraebus undatus* (Fabricius), firstly intercepted from imported logs and its risk to China. Plant Quarantine 30: 85–87.

Wu Y, Trepanowski N, Molongoski J, Reagel PF, Lingafelter SW, Nadel H, Myers SW, Ray AM (2017) Identification of wood-boring beetles (Cerambycidae and Buprestidae) intercepted in trade-associated solid wood packaging material using DNA barcoding and morphology. Scientific Reports 7(1): e40316. https://doi.org/10.1038/srep40316

Zack RS, Moore A, Miller RH (2009) First record of *Aphanisticus cochinchinae seminulum* Obenberger (Coleoptera: Buprestidae) from Micronesia. Coleopterists Bulletin 63(1): 41–43. https://doi.org/10.1649/0010-065X-63.1.41

Zhang X, Zhang YL, Zhang P, Cui ZJ, Han P, Gao GZ, Poland TM, Zalucki MP, Lu ZZ (2021) *Agrilus mali* Matsumura (Coleoptera: Buprestidae) density and damage in wild apple *Malus sieversii* (Rosales: Rosaceae) forests in Central Eurasia under four different management strategies. Entomologia Generalis 41(3): 257–266. https://doi.org/10.1127/entomologia/2021/0974

Zhu H-B, Gao Z-X, Han Z-C, Lu J, Chen J-D (2008) The jewel beetles (Buprestidae) intercepted on timbers from Papua New Guinea. Chinese Bulletin of Entomology 45: 647–650.

Supplementary material 1

Systematic list of all Coleoptera Buprestidae introduced around the world between 1850 and 2020

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